SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JULY 1914.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS

JULY 1914.

GENERAL PHYSICS.

1175. *Automatic Mercury Pump.* **Klein.** (Journ. de Physique, 4. Ser. 5. pp. 293–298, April, 1914.)—This pump differs from older ones of the same type in that the gases instead of being evacuated directly into the atmosphere are evacuated into a canal system connected with a column of water and, in place of the displacements of the mercury being produced by displacements of the receiver they are produced by the fact that the latter is put in communication alternately and automatically with the atmosphere and with the column of water by the action of a suitable arrangement. Diagrams are given showing the connections of the parts, and the method of working together with the rate at which the gases are removed are dealt with in detail. A. E. G.

1176. *Calibration Marker for Chemical Apparatus.* **K. Wolz.** (Zeitschr. Instrumentenk., Beib. 4. p. 37, Feb. 15, 1914.)—An upright frame provided with clamps for holding articles such as litre flasks, etc., is also fitted with sighting tube and marking point. The object is rotated by gearing when the diamond point is adjusted at the proper height. C. P. B.

1177. *Measuring Apparatus for Spectrograms.* **K. Wolz.** (Zeitschr. Instrumentenk., Beib. 5. pp. 53–55, March 1, 1914.)—A tape registering train is attached to the screw of the micrometer used for measuring the lines on spectrograms, so that the readings can be directly recorded as made.

C. P. B.

1178. *Slip-curves of an Amsler Planimeter.* **A. O. Allen.** (Phil. Mag. 27. pp. 643–648, April, 1914.)—When the pivot of an Amsler planimeter has been fixed on the paper, a family of curves may be drawn round it having the property that while the tracing-point moves along any one of them the reading of the wheel is constant, since it slips without rolling. The importance of these curves is that the instrument works least accurately when the tracer travels nearly along any of them; consequently, in measuring an area the pole should be so chosen that at all points of the perimeter the tracer may as far as possible cut the slip-curves orthogonally. It is sometimes advisable to divide the area into portions and use a different pole for each portion so as to attain this end. The equation of the slip-curves is here considered, and it appears that a knowledge of the chief geometrical properties of the curve leads to a proof of the principle of the instrument which differs from all those found in the usual text-books. A. W.

1179. *Application of the Displacement Interferometer to the Horizontal Pendulum.* **C. Barus.** (Amer. Journ. Sci. 37. pp. 501–518, June, 1914.)—The present paper is the outcome of an endeavour to register the excursions of the horizontal pendulum by displacement interferometry, not so much with a view to recording seismological phenomena as to approach by this means certain other problems, such as the tilting of the earth's surface relatively to the plumb-line, the measurement of the constant of gravitation, etc. If the inclination of the axis of the horizontal pendulum is but a few degrees to the vertical and a large framework is in question, the sensitiveness of the apparatus, when the excursions are read off in terms of light-waves, is remarkable. A full description of the apparatus is given together with a mathematical discussion of the sensitiveness to be expected. In conclusion the author describes some curious results, as yet unexplained, with experiments for measuring the gravitational attraction of two identical brass discs. For constant mass the attraction of nearly contiguous discs should increase roughly as the fourth power of their radius. For discs 20 cm. in diameter, however, the result is an invariable repulsion, several times as large as the estimated gravitational attraction, the equilibrium position being reached gradually in a few minutes. Since the discs are identical and in metallic connection, it would seem as if the absolute electric voltaic contact potential of the metals was being measured, but this effect would be at least 100 times smaller than the observed value. Similarly, the gravitational pressure increment of the film of air between the discs is too small.

H. H. Ho.

1180. *Production of High Vacua by Means of Finely-divided Copper.* **T. R. Merton.** (Chem. Soc., Journ. 105. pp. 645–646, March, 1914.)—Finely-divided copper, which may be obtained by reducing a solution of a copper salt and is sold commercially as "precipitated copper," absorbs gases with great readiness, the vapour pressure of the gases thus absorbed being so small that under suitable conditions it may be used for the production of high vacua. A bulb containing a few gm. of the copper is sealed to the vessel to be exhausted, the vessel being then partially exhausted by means of an air-pump and the copper heated to about 250°. When the air-pump is disconnected and the copper allowed to cool, the residual gases are rapidly absorbed. This absorption is not due to chemical combination, since the gases are liberated when the copper is heated. The carbon bands disappear first, then nitrogen, and finally hydrogen, but helium does not appear to be absorbed appreciably. Diminution in the absorbing power of the copper follows (1) the use of an excessively high temperature, (2) repeated use, or (3) prolonged exposure to the mercury-vapour from a mercury pump. Great care is necessary when the copper is being used for the first time, as the occluded gases may sometimes be evolved with such violence that the copper is blown through into the pump; consequently not more than one-third of the bulb should be filled with copper, and a short length of the tube connecting the bulb and the pump should be tightly packed with glass wool.

T. H. P.

1181. *Methods of Finding the Harmonics in a Fourier Series.* **J. Beaufort.** (Assoc. Ing. Él. Liége, Bull. 14. pp. 66–81, Jan., 1914.)—Assuming that the values of *y* in a periodic curve are known, the author obtains simple series formulæ for determining the amplitudes and phases of the harmonics in the Fourier expansion of *y*. The formulæ are practically identical with those given by S. P. Thompson [see Abstract No. 1806 (1911)]. The formulæ are proved by the elegant method of projecting the sides of a regular polygon on a straight line.

A. R.

1182. *Note on a Method of Calibrating Shock-testing Apparatus.* **G. Charpy** and **A. Cornu.** (Rev. de Métallurgie, 10. pp. 1283–1288, Nov., 1913.)—One of the main difficulties in shock testing is to show the relationship existing between the relative and absolute values and to compare the results obtained with various types of machine. With a view to overcoming these difficulties the authors propose to calibrate impact testers by testing bars in them under a known deformation which is not sufficient to start fracture. Of course it is necessary to ensure absolute homogeneity of the steel from which the bars are cut. Under otherwise similar conditions it has been shown that bars with sharp edges give higher and more erratic results than bars with rounded edges, and it is known that notching gives rise to errors which are not inherent in the machine. It is recommended, therefore, that the graduation test-bars should not be notched and should have their edges rounded off at a very definite radius. Eight series of tests in which the material, size of test-piece, weight and height of fall of tup were varied have shown that the values obtained are practically identical when the conditions of testing are identical. This appears to show conclusively the value of the method in comparing the relative regularity of two machines and in showing the concordance or discordance of their graduations.

F. C. A. H. L.

1183. *Calculation of Thin Oval Tubes under Uniform Pressure.* **R. Mayer-Mita.** (Zeitschr. Vereines Deutsch. Ing. 58. pp. 649–654, April 25, 1914.)—Gives analytical and geometrical treatment of the problem, and applies results to practice. Critical conditions of instability are discussed.

H. S. R.

1184. *Remarkable Rotational Phenomena of a Centrifugal Apparatus.* **K. Uller.** (Deutsch. Phys. Gesell., Verh. 16. 5. pp. 249–262, March 15, 1914.)—The experimental work recorded in this paper was carried out with an apparatus designed by König for the quantitative examination of surface effects. This briefly consists of two equal masses m_1, symmetrically placed and movable upon a transverse arm, and another mass m_2, movable along the vertical axis. m_2 is connected with both the masses m_1 by inextensible strings, which pass over pulleys situated where the vertical axis and transverse arm cross. In addition the mass m_2 is attached by a thin steel wire to a transverse thread. When this latter is burnt m_2 falls. The apparatus is so arranged that m_2 can fall upon a cork disc attached to the turning wheel, which absorbs the translatory kinetic energy of m_2. The system is partially rigid. A characteristic feature of the apparatus is that at any instant the angular velocity of all parts of the apparatus is the same as in a perfectly rigid body. If the apparatus be set in rapid rotation the rate only decreases slowly in consequence of the small frictional and resistance forces. If the thread be burnt which fixes the positions of the masses, the latter do not move immediately, but only when the rotation period exceeds a certain value. It might then be expected that the vertical weight would fall and strike the cork disc beneath, but such is not the case. Instead, the weight comes to rest as though a strong frictional force had been exerted. The new stationary position is maintained for an interval while the rotation velocity slowly decreases, then suddenly the weight moves again; the descending velocity first increases, but then slackens until a second stationary position is arrived at. This alternation of movement and rest is maintained as long as the apparatus dimensions permit, until finally the weight reaches the fixed cork disc. A mathematical discussion is given to explain these remarkable phenomena as a necessary consequence of the dynamics of the apparatus. Numerous curves are given to illustrate the various phases of the problem.

H. H. Ho.

1185. *Variation with Temperature of Internal Friction of Glass.* **C. E. Guye** and **[Mlle.] S. Vassileff.** (Archives des Sciences, 37. pp. 214–225, March, and pp. 301–328, April, 1914.)—Describes experimental determinations of the coefficient of internal friction of glass by decrement observations on oscillations performed by a torsion pendulum vibrating in a partial vacuum (25–30 mm. of Hg) and maintained by electrical means at various constant temperatures lying between 18° and 360° C. The assumption that the internal friction is proportional to the velocity and independent of the amplitude gives as the equation of motion, $I\,.\,d^2\theta/dt^2 + f\,.\,d\theta/dt + c\theta = 0$, where f is the coefficient of internal friction and θ is the amplitude. A short discussion of this equation is given. Experiments were made with ordinary, Jena, and lead glasses, the threads being of drawn glass in each case and examined for anisotropy both before and after the experiments by a polarisation microscope. The pendulum arrangement used was that of Guye and Freedericksz [Abstract No. 224 (1910)], modified slightly to avoid all possibility of shock to the fragile glass threads. The oscillations were recorded photographically. The glass threads were in each case 22·5 cm. long, and between 0·3 and 0·4 mm. in diam. The apparatus was first maintained for 2 hours at the highest temperature employed during the experiment, and observations were then made at a series of different temperatures down to the normal. A second series was made at the same points as before on again raising the temperature to its initial value. In no case did the differences between the two measurements at any one temperature exceed the experimental error. This indicated the absence of temperature hysteresis when the series was performed in the above manner. If, however, the measurements were made in the inverse order with a new thread the heating was found so to affect the glass as to cause a serious diminution in the log. decrement for the descending series of measurements, thus indicating molecular changes in the glass due to initial heating. The decrement did not vary with the amplitude, hence the oscillations obeyed the ordinary equation of motion given above. A change in the moment of inertia, I, however, was found to affect the value of f. The period of oscillation did not vary with the amplitude nor appreciably with the temperature. The decrement varied rapidly with the temperature in every case, rising to a maximum at 200° for ordinary glass, and at 250° for lead glass, then falling to a minimum before rising again still more rapidly. For Jena glass the decrement fell to a minimum at 120° and rose slowly from 120° to 250°, and then more rapidly to 860° C. From an examination of the photographic records of the oscillations, an approximate determination of the coefficient of damping could be obtained. The coefficients of friction thus deduced were: for Jena and lead glasses, both at 860°, 7·6108 and 18·4028 respectively; for ordinary glass at 810° C. it was 7·2875. J. W. T. W.

1186. *Air-flow in Wide Tubes.* **K. W. F. Kohlrausch.** (Ann. d. Physik, 44. 2. pp. 297–320, May 12, 1914.)—Describes two sets of experiments on ordinary air flowing under various pressures through glass tubes 250 cm. long and of sizes varying from 0·88 to 1·79 cm. in radius. In the first set of experiments the fall of pressure along each tube was measured by means of side tubes sealed into it at 5 different parts of its length, and leading to a Töpler pressure gauge. The curves connecting volume of air passing, ϕ, with pressure excess, p, were all found to consist of 2 straight lines meeting at well-defined points, all of which lay close to a straight line parallel to the "p" axis, as required by the Osborne Reynolds formula for the critical point at which gas-flow becomes turbulent. The straight lines forming the lower parts of the curves were in conformity with Poiseuille's law. The other lines when produced all appeared to cut the "ϕ" axis in the same point, ϕ_0, for any one tube. For different tubes ϕ_0/a is constant, where a is the radius of the tube. Assuming ϕ_0/a to depend only on the coefficient of friction, η, and the density, ρ, then $\phi_0/a = \pi k_1\eta/\rho$, where k_1 is a constant found to have the value 780 under the conditions of the experiment. Since the second part of the curve is a straight line, $\phi - \phi_0 = k_2\pi p a^4/\eta l$, where k_2 is a constant found by these experiments to have the value 0·0816. Hence within the limits covered by these experiments the equation of turbulent flow is $\phi = k_1\pi\eta a/\rho + k_2\pi p a^4/\eta l$. The critical point at which turbulent flow sets in is given by $\phi' = 4\phi_0/8$, and using the values of k_1 and k_2 found above, the critical velocity is found to be $1040\eta/\rho a$.

In the second set of experiments the distribution of pressure over the section of the tube was found, and the corresponding distribution of velocity calculated from the formula $v = \sqrt{2(\mathrm{P} - p)/\rho}$, where P is the pressure observed at any point by means of a Pitot tube, and p the pressure measured as in the first set of experiments. Irregularities were found even in the steady-flow portion, but these were probably due to disturbances produced by the Pitot tube. Treating the results obtained for the turbulent flow by a method analogous to that used for the first experiments, v now replacing ϕ, the equation for v is $v\rho a = 2\kappa\eta[(a^2 - r^2)/a^2 - 4/\mathrm{K}_2] + \mathrm{K}_2 p a^3\rho/\eta l$; here $\kappa = 1040$, $\mathrm{K}_2 = k_2 = 0{\cdot}0816$, and r is the distance of the point of observation from the axis of the tube. J. W. T. W.

1187. *Viscosity of Some Gases and its Temperature Variation at Low Temperatures.* **H. Vogel.** (Ann. d. Physik, 43. 8. pp. 1235–1272, April 16, 1914. Extract from Inaug. Dissertation, Berlin.)—The author has applied the Coulomb-Maxwell method of swinging for the determination of the viscosity of gases, modifying it so that it could be employed for the determination of the temperature variation of viscosity at low temperatures. As the most probable normal value of the viscosity of air at 273·1° abs., the author finds, from a critical comparison of all previous measurements, $\eta = 1724 \times 10^{-7}$. The author has now determined the viscosity relatively to this value for air, of 20 gases and vapours at 273·1° abs., the viscosity of ten of these being also determined at lower temperatures (down to 21° abs. in the case of H and He). As a result of his measurements, he points out that the above method is of equal or even of greater value than the ordinary flow method, for the measurement of the temperature variation of viscosity. With regard to the formula of Sutherland, $\eta \sim T^{\frac{1}{2}}/(1+C/T)$, the author shows that at low temperatures this formula does not agree with the results of experiment, but that C changes with the temperature, and that it tends to a value between 1·2 and 1·5 times the absolute boiling temperature. No satisfactory explanation of this has so far been given. The author points out relationships between the Sutherland constant, C, and the viscosity, and other physical properties, and, by a modification of the Lothar Meyer relationship, he has obtained an approximate formula for the calculation of viscosity from molecular volume, molecular weight, and the boiling temperature, which agrees fairly well with experiment. With the help of this formula the author has recalculated the viscosity of mercury-vapour. A. F.

1188. *Motion of Gases in Capillary Tubes and between Parallel Planes.* **R. Holm.** (Ann. d. Physik, 44. 1. pp. 81–96, April 28, 1914.)—In connection with the Siemens and Halske electrical anemometer [see Abstract No. 155 (1914)] the question arises of the law governing the motion of a gas through the space between two parallel plates, the gas entering this space through a circular hole in the centre of one of the plates. A theoretical treatment of the problem is here given, and experiments are described which give results in agreement with the theoretical conclusions. The flow through capillary tubes and through a tube of rectangular cross-section is also treated, the driving pressures in all cases being small, so that Poiseuille's law holds. A. W.

1189. *Decrement of Small Vibrations in the Flow of a Viscous Fluid.* **L. Hopf.** (Ann. d. Physik, 44. 1. pp. 1–60, April 28, 1914. From the Aachener Habilitationschrift.)—Deals mathematically with the critical state in which turbulence is on the point of setting in. Three types of vibration are recognised and are separately treated in detail. The paper contains a number of tables and graphs and should be referred to by those specially interested. E. H. B.

1190. *Outflow of Explosive Gases.* I. **C. Cranz** and **B. Glatzel.** (Ann. d. Physik, 43. 8. pp. 1186–1204, April 16, 1914.)—Describes the electric spark photography, at various instants, of the gases issuing from the muzzle of a gun on firing and sometimes with obstacles introduced in the line of flow. Over a score of photographic reproductions accompany the paper. [See also Abstracts Nos. 8 (1905), 185 (1907), and 145 (1913).] E. H. B.

1191. *Energy Theorem in Gravitation.* **G. Nordström.** (Phys. Zeitschr. 15. pp. 375–380, April 15, 1914.)—A mathematical discussion explaining the distinction between the gravitation theories of G. Mie and the author. It is also shown that the contradiction involved in Mie's form of the theory is avoided in that due to the author. [See Abstracts Nos. 354 (1913), 7 and 309 (1914).] E. H. B.

1192. *Possible Meaning of Quantum Theory.* **N. Umow.** (Phys. Zeitschr. 15. pp. 380–382, April 15, 1914.)—A mathematical discussion arriving at the following conclusion. Instead of the quantum theory we might retain Maxwell's partition of energy and introduce the following hypothesis: The ether (or the electromagnetic field) is selectively sensitive to the promiscuous motions of the molecules. This sensitiveness is related to the natural frequency of the molecule and is expressed by the fraction $1/h\nu$, where h is dependent on the properties of the ether and is therefore a universal constant, and ν is the natural frequency of the molecule. E. H. B.

1193. *Nordström's Gravitation Theory.* **A. Einstein** and **A. D. Fokker.** (Ann. d. Physik, 44. 2. pp. 321–328, May 12, 1914.)—Discusses this theory, and by a different method reaches a result in agreement with it. The authors also point out that the theory under discussion has the advantage of satisfying the theorem of the equivalence of the inertia mass and the gravitation mass.
E. H. B.

1194. *Effect of the Gangetic Alluvium on the Plumb-line in Northern India.* **R. D. Oldham.** (Roy. Soc., Proc. Ser. A. 90. pp. 32–41, April 1, 1914.)—This paper deals with the remarkable character of the deflections of the plumb-line at stations near the southern edge of the Himalayas, and examines Burrard's conclusions which, regarding the structure of the range, partly contradict those drawn from geological observations. Briefly the geodetic facts are that along the southern edge of the Himalayas very high northerly deflections, amounting to about 40″ of arc, are found, which rapidly decrease in a southerly direction by about 30″ in as many miles, after which they become much more gradual. Northerly also there is a decrease, though not so rapid as to the south. Burrard's hypothesis, in explanation of these facts, is the existence of a belt of deficient density, of considerable depth, but of no great width, along the southern edge of the Himalayas. As this rift is on a scale of magnitude far in excess of anything for which there is geological precedent, the author has been led to investigate whether some other explanation was possible more in accordance with geological observations. The geological structure is as follows: Along the southern edge there is a great fault separating the older rocks of the range from the upper tertiary, Siwalik beds, which Medlicott showed to have been formed under conditions similar to those of the recent deposits in the Gangetic depression, and to be the lower, marginal deposits of the same continuous formation, of which the Gangetic alluvium forms the uppermost members. The depth of this formation along the northern margin is certainly great, nowhere less than 10,000 ft., and possibly 30,000 ft. in places. On the southern margin the thickness is small, and the deposit thins out over an old land surface of rock. Between these two limits it is natural to suppose that the depth of the alluvium decreases gradually from north to south, and its mean density has been taken at 2·1, the mean density of the rock forming the sides and floor of the depression being about 2·7. It is the effect of this large bulk of material, having a density of only about seven-ninths of the average density of surface rock, which has been investigated. The method adopted was based on Hayford's system of compartments, the trough being assumed to run east and west, with the deep side on the north, and divided into belts of 10 miles wide, running parallel to the margins, in each of which the depth was assumed to be uniform and equal to the mean depth of the belt. The data obtained are subjected to the necessary corrections, and the general conclusions to be drawn appear twofold: (1) that the local deflections of the plumb-line, produced by underground topography, along the region bordering the southern margin of the Himalayas, are of such magnitude as to make the observations, at stations situated in that region, of small geodetic value, unless allowance is made for the invisible, as well as the visible, topography; and (2) that there is no geodetic justification for the assumption of the existence of a deep and narrow rift, filled with material of lesser density than the rock on either side, or for any modification of the deductions, regarding the form of the floor of the Gangetic depression, which have been drawn from geological observation. H. H. Ho.

1195. *Principle of Similitude.* **R. C. Tolman.** (Phys. Rev. 3. Ser. 2. pp. 244–255, April, 1914.)—This article presents some considerations which appear to have validity throughout the field of physical science. These conclusions are drawn from a single postulate or new principle which may be stated as follows.

The fundamental entities out of which the physical universe is constructed are of such a nature that from them a miniature universe could be constructed exactly similar in every respect to the present universe. This is called the *principle of similitude.*

This fundamental postulate is a relativity principle, viz. the principle of relativity of size. In the body of the paper it is shown that relations must hold between the changes of lengths, masses, time intervals, energy quantities, etc., in order to construct the miniature world in question. E. H. B.

1196. *Essential Foundations for Atomic Models.* **F. A. Lindemann.** (Deutsch. Phys. Gesell., Verh. 16. 6. pp. 281–294, March 30, 1914.)—The following propositions may be considered as experimentally established results to which all atomic models must conform: (1) Atoms are impenetrable to atoms or electrons of speeds less than a value lying between 3×10^8 and 6×10^6 cm./sec., and penetrable to those of higher speeds [Abstracts Nos. 1319 (1913), and 1031 (1914)]. The atomic volume is therefore not completely occupied by atoms. (2) Except for radioactive elements, atoms remain stable for extremely long periods of time. (3) Atoms contain electrons emitting spectra due to very slightly damped electric waves, arising from thermal motions, chemical action, electric resonance, and electronic collisions. These spectra are frequently expressible by empirical formulæ of the type $\nu = A(r_1^{-2} - r_2^{-2})$, when ν is the frequency, A a constant, and the r are integers of which r_1 is the smallest. (4) Even the high-frequency Röntgen spectra are due to undamped vibrations, and the principal lines for atomic masses between 40 and 65 are of the type $\gamma = Ar^2$, where r may have values from 19 to 29 [Moseley, Abstract No. 467 (1914)]. (5) A lower limit to the number of free electrons in an atom is given by the deviation of Röntgen rays, and with results agreeing with those of (1). (6) The existence of strongly damped electronic vibrations is shown by the selective photo-effect, and may be due either to vibrations of single atoms or of molecular aggregates. Franck and Hertz's results [Abstract No. 1858 (1913)] suggest the former. The models may be static or kinetic, but in the former case their stability requires an otherwise unknown repulsion which may be dispensed with in the latter, but then electromagnetic radiation must also be excluded. All electrons revolving synchronously must form a single ring [Nicholson, Nature, 92. p. 630, 1914], and for such differences of frequency as between the Röntgen and visible rays this seems hardly possible. All models must fulfil the dimensional conditions previously indicated [Abstract 475 (1914)]. With the same notation, the author considers four cases in detail, with the subsidiary hypotheses necessary, viz., (1) $x = 0$, $\gamma = Ak/mr^2$; (2) $x = 1/2$, $\gamma = A(e^2Nn/mr^2)^{\frac{1}{2}}$; (3) $x = 1$, $\gamma = ANne^2/hr$; (4) $x = 2$, $\gamma = AN^2n^2e^4m/h^3$. The latter gives Bohr's formula as applying both to Röntgen and visible rays free from most of his assumptions. G. W. DE T.

1197. *Recent Physical Discoveries.* **J. J. Thomson.** (Engineering, 97. pp. 323–325, March 6; 354–355, March 13; 390–391, March 20; 425–427, March 27; 443–444, April 3, and pp. 496–499, April 10, 1914. Discourses delivered before the Royal Inst.)—The first three of these discourses were concerned with the nature of the forces exerted by atoms on each other, and the bearing of this on chemical affinity, while the fourth dealt with metallic conduction. At the outset the importance of the actions exerted between atoms was insisted on, for upon them depend such properties of matter as stiffness and tenacity, those involved in changes of state from solid to liquid, and from liquid to gas; the presence or absence of crystals; but in addition to this there was involved the vast subject of chemistry. The work of the late W. Sutherland was held to be of great value in these connections. Sutherland assigned to each atom a specific attracting power. He held that the variation of this force with distance was the same for all atoms, but that its magnitude depended on a specific constant different for each element. He assumed that each element contained both a positive and a negative charge, but that the two were not quite in the same position. There was thus a residual external field, each atom resembling a little magnet—this arrangement being known as an electric doublet. The application of this view to the subject of valency is worked out and illustrated by figures. The remaining lectures deal with Röntgen-ray phenomena and with specific heat. E. H. B.

1198. *Gyroscopic Quanta.* **R. A. Fessenden.** (Science, 39. p. 533, April 10, 1914.)—Points out that it follows from the author's electrostatic-doublet vortex theory of matter, that the energy radiated when a distortional ether wave strikes an atom will be given off in quanta and be proportional to the frequency. The simplest way of seeing this is to take the well-known experiment in which a gyroscope is held in the hand and the body revolved first one way and then the other. On turning the body one way no effect is produced on the gyroscope. On turning the other way the gyroscope resists and is upset, and the axis then points in the opposite direction. It may easily be shown that the amount of work done in upsetting the gyroscope varies directly as the angular velocity of rotation of the body, or, in the case of the atom and ether wave, is directly proportional to the frequency. E. H. B.

1199. *Crushing Tests on Cylindrical Tubes of Lead.* **A. Kirsch.** (Ferrum, 10. pp. 55–59 and 81–91, 1913. Rev. de Métallurgie, 11. pp. 73–81, Feb., 1914. Extract.)—A long abstract of a paper on the relation between shock crushing tests and the length, external diam., and sectional area of leaden tubes all of equal weight. F. C. A. H. L.

1200. *Critical Loads for Ideal Long Columns.* **A. Morley.** (Engineering, 97. pp. 566–568, April 24, 1914.)

1201. *Fluid Motions.* **Rayleigh.** (Engineering, 97. pp. 442–443, April 3, 1914. Nature, 93. pp. 364–365, June 4, 1914. Lecture delivered at the Royal Inst., March 20, 1914.)

1202. *Studies in Brownian Movement.* I. **J. H. Shaxby and E. Emrys-Roberts.** (Roy. Soc., Proc. Ser. A. 89. pp. 544–554, March 2, 1914.)—Deals with the Brownian motions of bacterial spores. L. H. W.

1203. *On the Relativity of Accelerations in Mechanics.* **H. Reissner.** (Phys. Zeitschr. 15. pp. 371–375, April 15, 1914.)—Highly mathematical.

1204. *Minkowski's Mechanics.* **B. Weinstein.** (Ann. d. Physik, 43. 6. pp. 929–954, March 20, 1914.)—A highly analytical paper dealing with the world-constant, and the mechanics of the system. E. H. B.

1205. *The New Mechanics.* **L. T. More.** (Science, 39. pp. 595–599, April 24, 1914.)—A semi-popular treatment contrasting the new mechanics, recognising the change of mass with speed, with the classical view in which mass was constant. E. H. B.

1206. *Pulsating Spheres and Gravitation.* **A. Korn.** (Comptes Rendus, 158. pp. 982–984, March 30, 1914.)—Discusses the conditions under which pulsating spheres immersed in an incompressible fluid would attract or repel. E. H. B.

1207. *Momentum of Progressive Waves.* **Rayleigh.** (Phil. Mag. 27. pp. 436–440, March, 1914.)—The author here makes some extensions of an approximate mathematical theory developed in an earlier paper [Abstract No. 126 (1906)]. In the first place, the conclusions formerly obtained on the supposition of small disturbances are shown to have a wider validity. He also calculates the momentum of a long progressive wave of mean elevation zero in a uniform canal, and notes the application to periodic waves moving on the surface of deep water. G. W. DE T.

1208. *Further Experiments with Liquid Drops and Globules.* **C. R. Darling.** (Phys. Soc., Proc. 26. pp. 118–119, Feb., 1914.)—The experiments described are the following:—(1) Communicating drops. (2) Structure of liquid jets. (3) Liquid spheres enclosed in a skin of another liquid. (4) Mixed vapour and liquid drops. (5) Expanding globules. (6) Combination of floating globules. For details the original pages must be consulted. [See Abstracts Nos. 588, 1081 (1911).] L. H. W.

1209. *Tate's Law and the Variation of the Size of Drops with the Frequency of Fall.* **P. Vaillant.** (Comptes Rendus, 158. pp. 936–938, March 30, 1914.)—When a drop is detached from a capillary orifice, the perimeter of the section of rupture is considerably less than that of the orifice, and the surface tension calculated according to Tate's law is much too small. It is usually assumed that the weight of the drops is independent of their frequency, whereas actually this weight shows a continual variation, which may exceed a quarter of the total weight. The results of the author's measurements show that the weight of the drop is at first sensibly constant and that it begins to increase as soon as the frequency surpasses 15 per minute. The increase is initially rapid but later proceeds more slowly until at a frequency of 100 the weight passes through a maximum. As the frequency increases continuously, the weight of the drop exhibits three further maxima, each greater than the preceding, and subsequently appears to diminish continuously. It is evident that, when the increased frequency causes the diminution of the volume of the drop to exceed a certain limit, the drop assumes a different form, passage from one form to the other being in general sudden. T. H. P.

1210. *Method for the Determination of the Surface Tension of Amorphous Bodies.* **B. Berggren.** (Ann. d. Physik, 44. 1. pp. 61–80, April 28, 1914.)—In the case of a thread hanging vertically, surface tension causes a compression, gravity an extension. The velocity of deformation is determined partly by the resultant of these two stresses, and partly by the viscosity of the substance. When the viscosity of deformation is zero, the resultant is also zero, and the surface tension can therefore be calculated. With metals, no conclusion regarding the surface tension can be reached, as the metals frequently have a distinctly crystalline structure, which is also modified by "working." In the case of amorphous substances, however, the method indicated above can be applied even when the viscosity is so great as to make determinations by other methods impossible. The author has made such determinations in the case of copal. The accuracy of the method is diminished greatly by elastic after-effects, which give rise to an apparent increase of the surface tension, which is sometimes of considerable amount. In such cases, however, the method yields an upper limit for the surface tension. The experimental results which have been obtained yield values for the surface tension of the same order as those for true liquids. They do not support, therefore, the view that there is an essential difference between the solid and liquid bodies in this respect. A. F.

1211. *Relations between Pressure, Temperature, and Height of the Troposphere over the European Plain.* **W. Köppen** and **F. Wedemeyer.** (Meteorolog. Zeitschr. 31. pp. 1–15, Jan., and pp. 75–86, Feb., 1914.)—Observations by means of registering balloons liberated from Hamburg, Kutschino, Lindenberg, Pawlowsk, Strassburg, and Trappes are used and the methods of correlation are applied to them to obtain correlation coefficients between the quantities indicated. The general plan of the paper is very similar to that of the memoir of W. H. Dines, in connection with the results of British soundings [see Abstract No. 1685 (1912)], and the results from the European observations agree remarkably well with those deduced by Dines from the British observations. R. C.

1212. *On the Winds in the Lowest Layers of the Atmosphere.* **G. Hellmann.** (Preuss. Akad. Wiss. Berlin, Ber. 18. pp. 415–437, 1914.)—Three anemographs were exposed at heights of 2, 16, and 32 m. above the ground at a wireless station on the plain to the north-west of Berlin, and the mean increase of wind-velocity with height was determined from their records. In order to obtain a wind record free from the major part of the disturbing influences of the ground, and fairly representative of the velocity of an air-current, it is found sufficient to place the exposed parts of the anemograph at a height of about 15 m. above the ground, which is supposed level and free from trees and other obstructions. The anemograph should be exposed on a support which produces the minimum of disturbance in the air-current, *e.g.* on an open steel tower, or a flagpole, *not* on a building.

It is known that the diurnal variation of wind velocity at the earth's surface in these latitudes shows a maximum in the afternoon and a minimum about midnight. On mountain-peaks and in the free upper air, however, the variation is reversed, the maximum occurring during the night, and the minimum during the day. The author now shows that with feeble winds the midnight maximum of the upper air extends downwards to within a few metres of the surface of the ground: while, on the other hand, with strong winds the surface *régime* extends to considerable heights. For the average of all winds the surface variation is contained in a layer which has a thickness of about 50 m. in winter and of about 100 m. in summer. At sea the surface variation as observed on land is absent: indeed, there is little diurnal variation of wind at sea in temperate latitudes, but on the average the maximum occurs at night.

Reasons are given for these results, depending upon the disturbance in the general westerly drift of the atmosphere caused by the convection currents which are produced by the daily heating of the earth's surface by the sun. R. C.

1213. *Observations Made at the Lyons Observatory during the Storm of February* 22, 1914. **P. Flajolet.** (Comptes Rendus, 158. pp. 744–746, March 9, 1914.)—This storm was the most severe experienced in the Lyons district for 30 years. The mean velocity of the wind was greater than 17 m./sec. from 4h. 40m. to 14h. 40m., and it reached 23 m./sec. from 6h. to 10h. 40m., the max. velocity observed in a gust being 41·6 m./sec. at 8h. 24m. The self-recording instruments show that a rapid fall of the barometer occurred during the whole time that the gale lasted, and was succeeded by a very rapid rise of the barometer. The beginning of the rise in pressure was accompanied by a sharp shower of rain, a rapid diminution in wind velocity, a veer in wind direction, and a sudden drop in temperature. R. C.

1214. *Micro-seismic Motion.* **W. Pechau.** (Phys. Zeitschr. 15. pp. 415–416, April 15, 1914.)—The author here communicates some conclusions derived from observations extending over several years which are opposite to those given by Gutenberg [Ibid. 11. p. 1184, 1910]. He distinguishes two kinds of micro-seismic movement, viz. (1) those of 5 to 10 secs. period; (2) those of 40 to 80 secs. period. The former he terms micro-seismic, the latter pulsations. Gutenberg also recognises two kinds of motion, (1) due to local causes such as traffic, storm, surf; (2) due to more universal causes such as the impact of breakers against steep coastlines, wind, and frost. The present author at Jena has not recognised any of Gutenberg's local movements. He ascribes the micro-seismic movements as due to wind action entirely, the period and amplitude being dependent on temperature. Pulsations, on the other hand, are dependent on the air-pressure gradient, and the author only accepts Hecker's conclusion that they are caused by wind action in so far as the latter is connected with the changes in air pressure. The steeper the latter, the larger the amplitude of the pulsations. H. H. Ho.

1215. *On the Action of Gravity on Gaseous Mixtures, particularly in the Earth's Atmosphere.* **G. Gouy.** (Comptes Rendus, 158. pp. 664–668, March 9, 1914.)—The result of this mathematical analysis is that if the earth's atmosphere became perfectly quiescent, a separation of oxygen and nitrogen would gradually be partially effected by gravity, the air at the surface would become relatively rich in oxygen and poor in nitrogen, while the higher layers would become richer in nitrogen. Where the pressure is 0·1 of an atmosphere, say at a height of about 15 km., it is found that it would take 988 years for the air to become 1 per cent. poorer in oxygen, and the conclusion is therefore drawn that in the actual atmosphere, which is not quiescent, the action of gravity on the composition of the air is too slow to produce any sensible effect. R. C.

1216. *Investigation of Deep-sea Deposits.* **J. Joly.** (Roy. Dublin Soc., Proc. 14. No. 18. pp. 256–267, April, 1914.)—In 1897 the author communicated to the Royal Dublin Society a suggested method of boring into such rocks as might be exposed on the sea-floor. The boring-machine then described involved a motor to drive the drill and an insulated wire from the surface. This machine has been improved while retaining the essential features. Difficulties and expense are involved in transmitting electric power from the surface to the bottom at great depths, while to develop power below from storage cells or wound-up springs presents even greater difficulties. Recently it occurred to the author that the pressure of the water prevailing at great depths might itself be utilised to provide the necessary power *in situ*. The principle is simple, being the discharge of the working substance, namely the water, after it has done work in a hydraulic engine, into an empty vessel of sufficient strength to resist the pressure at the bottom. The engine may be of the ordinary reciprocating type with the usual directions of the pressure reversed and acting from without inwards, or the motor may be of the Pelton-wheel form, the wheel being protected from the pressure and water directed from without upon it, the spent water finding its way to the receptacle. A detailed description of a suitable hydraulic engine for boring into the soft sediments and oozes on the ocean-floor is given, illustrated by several plates and diagrams. The mechanism of the drill also receives attention, the various precautions for ensuring efficient working under different conditions being discussed. As it is very desirable to be able to follow the operation of the drill from the boat above, the author proposes to utilise the well-known acoustic properties of water to this end. Above the deck of the sounder a large bell is attached. A hammer is so placed that raised ribs on the drill-tube lift the hammer and again allow it to fall forcibly on the bell four times in a revolution of the drill, a strong spring occasioning the blow. A telephone suspended beneath the surface of the water above enables these strokes of the hammer to be heard. It is easy to arrange such distinctive characters for the succession of hammer-strokes as will enable the position of the drill to be known by the listener above. It is not difficult to reckon up the strokes so that the exhaustion of the bottles can be anticipated and the operation of withdrawing the drill proceeded with while there is still power in the engine, so that the drill is reciprocated back and forth while it is being withdrawn, and its release from the ooze in this way facilitated. The paper concludes with a description of certain modifications of the customary methods of raising sounding-machines in deep water, as it is impossible to operate always under still conditions. H. H. Ho.

1217. *Occurrence of Ozone in the Upper Atmosphere.* **J. N. Pring.** (Roy. Soc., Proc. Ser. A. 90. pp. 204–219, May 1, 1914.)—With the aid of an aqueous solution of potassium iodide ozone can be distinguished from nitrogen oxides in very diluted gas mixtures, provided the temperature does not fall below the freezing-point of the reagent −240° C. Hydrogen peroxide would give the same reaction as ozone, but can be distinguished from it by the titanium sulphate test. The action of ultra-violet light on air is studied in a bulb, immediately surrounding the quartz tube of the mercury lamp, so that the rays pass through the quartz walls directly into the air; the whole apparatus is immersed in water. The arc is started with the aid of an induction coil, after joining the lamp terminals to a source of current at 100 or 200 volts; the secondary of the coil is also connected with one of these terminals and, further, with a wire wrapped round the annular jacket of the lamp; the coil is worked until a glow discharge, followed by the arc, is seen in the lamp. In this apparatus no nitrogen oxides nor hydrogen peroxides were produced; the ozone production decreased when the gas pressure was reduced, from 0·01 per cent. at 760 mm. to 0·0014 per cent. at 80 mm. With the absorbing vessels of Hayhurst and the author, atmospheric measurements were conducted in the Alps at altitudes between 2000 and 3500 m. Free balloon measurements were made from Manchester. In the Alps the mean quantity of ozone found in one volume of air was $2{\cdot}5 \times 10^{-6}$ at 2100 m., and $4{\cdot}7 \times 10^{-6}$ at 8580 m.; the amount did not increase much at higher altitudes up to 20 km.; the ozone contents fluctuated; nitrogen oxide and hydrogen peroxide were not observed in the upper atmosphere. The amount of ozone stated sufficed, as laboratory experiments indicated, to impart a blue colour to the gas; thus ozone would contribute to the blue colour of the sky. H. B.

1218. *Cooling of the Earth.* **A. Véronnet.** (Comptes Rendus, 158. pp. 538–541, Feb. 23, 1914.)—An estimate is made of the probable rate of cooling of the earth, taking various assumptions as to the composition of the surface and interior materials. C. P. B.

1219. *Zodiacal Light.* **C. Abbe.** (Mount Weather Observatory, Bull. 6. 8. pp. 78–80, 1914.)—The question is raised whether the cosmical dust which possibly gives rise to the zodiacal light is closely connected with the upper regions of the earth's atmosphere. C. P. B.

1220. *Zodiacal Light.* **M. Hall.** (Mount Weather Observatory, Bull. 6. 8. pp. 61–67, 1914.)—Observations of the position, breadth, and illumination of the zodiacal light were made from Dec., 1911, to Nov., 1912, in the course of an investigation to ascertain whether the phenomenon be in the ecliptic plane or in the invariable plane of the solar system. Tables are given showing the geocentric longitudes and latitudes of points on the central axis of the band, and of its breadth at points whose geocentric longitude are known. The author concludes that the zodiacal light is due to particles of cosmic dust remaining after the formation of the planets of the solar system. C. P. B.

1221. *Diurnal Variation of Refractions.* **R. H. Tucker.** (Lick Observatory, Bull. No. 281.)—Observations of a fundamental character for the investigation of diurnal variations of refraction were commenced at Mount Hamilton, California, in 1905, and the results of the first year's work are discussed in the present paper. The plan included two programmes, each of 4 hours' duration and differing by 12 hours of right ascension. An indication is shown of a difference in the effect of refraction between day and night observations, the amount of which does not appear to depend upon either the barometric pressure or the temperature. From a detailed discussion of the spectral types of the stars employed it is also concluded that the difference has not any definite relation to spectral type or colour. C. P. B.

1222. *Distribution of Sun-spots in Heliographic Latitude.* **E. W. Maunder.** (Roy. Astronom. Soc., M.N. 74. pp. 112–116, Dec., 1913.)—Curves are given showing the distribution of sun-spots in latitude for the period 1874–1913, in continuation of the results communicated in previous papers. Examination of the diagram shows how clearly Spoerer's law is followed, there being but a single movement in either hemisphere, the trend of which is downward, from one minimum to the next minimum. Curves of sun-spot area are also given for the same period, to show the intimate agreement in the periodicity both in latitude and area. The only period represented with certainty is that of 11·1 years. Both hemispheres have the same period, but differ slightly in phase. Reference is made to the fictitious periodicities which may be introduced by mere statistical analysis of the data. C. P. B.

1223. *General Displacement of Lines in Solar Spectrum.* **J. Evershed.** (Kodaikanal Observatory, Bull. No. 36. Nature, 93. p. 69, March 19, 1914. Abstract.)—From a series of the arc and solar spectra of iron it is concluded that the general displacement of lines to the red in the solar spectrum relative to the terrestrial spectrum cannot be accepted as due to pressures in the solar atmosphere. The lines which show most shift in the laboratory under pressure are least affected in the sun. It is proposed to regard the phenomenon as due to a movement of descent with a negative acceleration. C. P. B.

1224. *Contraction and Heat of the Sun.* **A. Véronnet.** (Comptes Rendus, 158. pp. 398–400, Feb. 9, 1914.)—A series of calculations are presented to determine the relations between the rate of contraction, heat radiated, and duration in certain state, on various assumptions as to the solar constitution, liquid or gaseous. C. P. B.

1225. *Capture of Comets by Jupiter.* **Fessenkoff.** (Comptes Rendus, 158. pp. 541–544, Feb. 23, 1914.)—An analysis is made of the conditions necessary for the probable disturbance of a cometary orbit by Jupiter to be sufficient to cause the comet to become a member of the solar system. The probability appears to be chiefly dependent on the inclination of the cometary orbit to the ecliptic. C. P. B.

1226. *Spectrum of Comet Brooks* (1911*c*). **W. H. Wright.** (Lick Observatory, Bull. No. 209.)—Photographic records of the spectrum of Comet Brooks were obtained with slit spectrographs and a prismatic camera without slit, during Sept. and Oct., 1911. An interesting feature is that the tail bands were quite faint at first, and later became much more prominent relative to the intensity of the nucleus. Very marked changes are described which occurred in the relative intensities of some of the bright lines in the spectrum of the head and nucleus. Tables are given showing the lines measured from λ3864 to λ6680, with reference to their probable coincidence with the CO spectrum as published by Fowler. A series of excellent reproductions of the spectra is included with the paper. C. P. B.

1227. *Photographic Observations of Comet Brooks* (1911*c*). **C. C. Kiess.** (Lick Observatory, Bull. No. 239.)—Lists are given of the details of 29 photographs of Brooks' comet of 1911, taken at the Lick Observatory, with notes calling attention to the chief points of interest. Seven of the plates are reproduced in the paper, showing the changes in the tail and head envelopes. C. P. B.

1228. *Magnesium Lines in Stellar Spectra.* **F. E. Baxandall.** (Cambridge Phil. Soc., Proc. 17. No. 4. pp. 323–325, Jan. 30, 1914.)—In a recent paper by Fowler [Abstract No. 1948 (1913)] four magnesium spark lines are recorded which do not belong to the series considered. These four lines occur in a part of the spectrum available for comparison with stellar spectra, the series lines, with the exception of λ4481·3, being outside the region usually obtained in stellar spectrum photographs. Photographs of the spectra of α-Cygni and α-Canis Majoris obtained at South Kensington show lines whose wave-lengths are λ4384·7, λ4428·4, λ4434·3. Fowler's wave-lengths for the Mg lines are λ4384·86, λ4428·20, λ4434·20. Another stellar line λ4391·0 is probably the proto-titanium line λ4391·19, since all the other prominent enhanced lines of Ti are represented in these stellar spectra, but the Mg line given by Fowler at λ4890·80 may enter into the composition of the line λ4891·0. Comparison of the line λ4884·7 with two neighbouring lines whose wave-lengths are accurately known leads to the conclusion that either the laboratory line and the stellar line are not identical, or the wave-length given by Fowler is from 0·1 to 0·2 Å. too high. The 4481 line of Mg, which is a very strong line in Fowler's spectrum giving the Mg lines under discussion, is, in stellar spectra, about at its maximum in such stars as α-Cygni and α-Canis Majoris, in which these other Mg lines appear to exist. A. W.

1229. *Spectrum of η Carinæ.* **J. H. Moore** and **R. F. Sanford.** (Lick Observatory, Bull. No. 252. pp. 55–61, 1914.)—The spectrum of this star has recently been photographed at the Lick Observatory with a prism spectrograph giving a linear dispersion of 86 Å. to the mm. at H_γ. The spectrum is essentially one consisting of bright lines, and shows no dark lines such as have been described by former investigators. Many of the constituent lines have been identified with the enhanced lines of Fe, Ti, and Cr, but a considerable number of fairly strong lines in the spectrum are still unidentified. The lines of helium, the nebular lines, and magnesium λ4481 are absent, but a comparison of the spectrum with that of Novæ in the early stages of their history indicates a close connection between the two spectra. C. P. B.

1230. *Cluster Variable RR. Lyræ.* **C. C. Kiess.** (Lick Observatory, Bull. No. 282.)—From a series of photometric observations made at the Lick Observatory it is concluded that the star RR. Lyræ belongs to the class of Cluster variables. Comparison of the times of maximum indicated a period of 0·566826 day. Radial velocity observations show the star to be a spectroscopic binary, with period equal to that given by the light-changes. C. P. B.

1231. *Correlation of Stellar Spectra, Colours, and Parallaxes.* **P. Nashen.** (Astronom. Nachr. No. 4722. Nature, 98. p. 145, April 9, 1914. Abstract.)—A list of 246 stars is given, showing their parallax, spectrum type, and colour. The analysis of these data leads to the conclusion that the white stars decrease with increasing parallaxes, while the red stars increase under similar conditions. C. P. B.

1232. *Orbit of δ Cephei.* **J. H. Moore.** (Lick Observatory, Bull. No. 284.)—Thirty-eight spectrograms of this interesting binary were obtained at the Lick Observatory during the latter part of 1907, comparisons being made with the spectrum of α Ursæ Minoris, which is very similar. Curves are given showing the variations of radial velocity as measured, and their very decided relation to the variations in brightness of the star. C. P. B.

1233. *Distribution of Nebulæ.* **E. A. Fath.** (Astronom. Journ. Nos. 658–9. Observatory, No 472. pp. 185–186, March, 1914.)—A discussion is given of a systematic search for nebulæ in Kapteyn's "Selected Areas," plates having been taken covering 189 out of the 206 regions comprising the scheme. The exposures were made with the 60-in. reflector at Mount Wilson, and each lasted one hour. A number of new nebulæ are noted, and an interesting series of conclusions as to the general distribution are given. The concentration of nebulæ near the north galactic pole is very noticeable, but there are great variations in the density of distribution. There is a complete absence of these nebulæ where the Milky Way crosses the sky. C. P. B.

LIGHT.

1234. *A Photographic Prismatic Astrolabe.* **R. Baillaud.** (Comptes Rendus, 158. pp. 1249–1252, May 4, 1914.)—The author discusses certain errors of the instrument, and suggests that they may best be avoided by employing photography. Let a photographic plate be placed nearly in, and parallel to, the focal plane of the instrument. Then the direct and reflected images of a star will each trace on the plate a trail which may be interrupted at definite intervals. In this way points $a_1a_2a_3$, ... , $b_1b_2b_3$ . . . , corresponding to the same instants, can be obtained on the two trajectories. Assuming the prism to be correctly adjusted, and the operation to take place near coincidence, the horizontal velocities of the images are the same, and their vertical velocities are equal and opposite in sign. Hence, the bisector of the angle between the two trails defines the horizontal direction on the plate. The line connecting the two images at the moment when, what is for convenience called "coincidence" would occur, is the horizontal line passing through the middle points of the lines joining corresponding points a_1b_1, a_2b_2, ... of the two trails, and can therefore be determined. The time of coincidence can be deduced from measurement of the intervals a_1a_2 . . , b_1b_2 . . , and knowledge of the time the image takes to traverse them. The problem is simplified when the two trajectories are nearly vertical in the field of view. If the plate is put in the same position at each observation, any slight error in focusing need not be taken into account. In any case such error may be made extremely small by employing Hartmann's, or other, method of finding the focus. A. E.

1235. *New Arrangement of Mirrors for Lighthouses, etc.* **E. Cannevel.** (Comptes Rendus, 158. pp. 984–986, March 30, 1914.)—This arrangement consists of a stepped mirror, which is composed of a number of parabolic and annular elements, and is combined with a spherical mirror. The different paraboloidal fragments all have the same focus, and part of each projects rays directly to infinity, whilst the other part, masked by the succeeding step, also sends the rays to infinity, but by way of the ring connecting them, the angle of incidence making the rays pass through the spherical mirror placed at the bottom of the truncated, circular stepped mirror. This arrangement of mirrors increases considerably the reflecting surface and, since the images projected by the rings are not exactly superposed, it may be used with filament lamps. Difficulty having been experienced in making the mirror in metal, use is made of glass silvered electrically by kathodic projection under a bell, which, after being evacuated, was filled with hydrogen under pressure in order to prevent oxidation of the metal. T. H. P.

1236. *Prism with Curved Faces.* **C. Féry.** (Journ. de Physique, 4. Ser. 5. pp. 261–265, April, 1914.)—The author has previously shown how a prism with curved faces, one of the curved faces being made reflecting, can be used in the construction of a spectrograph [see Abstract No. 586 (1910)]. It is here shown how such prisms may be employed generally to give a pure spectrum, even though the incident beam is not parallel. If the beam is divergent a concave face is used for the incident light, and a convex face when a convergent beam is employed. The diacaustic of such a prism is situated on a circle, whatever the dispersive properties of the material, and this circle contains the centres of the curved faces of the prism. A description is given of the way in which prisms with curved faces may be used (i) for transforming a convergent beam into a spectral image, *e.g.* the image of a star furnished by an astronomical objective ; (ii) for the study of infra-red spectra ; and (iii) for the study of ultra-violet spectra. For particulars of these the original paper should be consulted. A. W.

1237. *Polarisation Spectrophotometer with Brace Prism.* **H. B. Lemon.** (Astrophys. Journ. 39. pp. 204–212, April, 1914.)—A description of a modified form of the Brace instrument containing a simple polarising arrangement in one of the collimators. The sensibility of the instrument approaches that of the eye to differences in intensity, and while it preserves the great economy of light furnished by the Brace prism and the excellence of elimination of the dividing line, there is complete freedom from the cumbersome calibrations necessary with the older form of the instrument. C. S. G.

1238. *Diffraction of Light by Spheres of Small Relative Index.* **Rayleigh.** (Roy. Soc., Proc. Ser. A. 90. pp. 219–225, May 1, 1914.)—Keen and Porter have described curious observations on the intensity and colour of light transmitted through small particles of precipitated sulphur about the size of the wave-length of the light [see Abstract No. 645 (1914)]. The present paper then treats the matter mathematically upon certain assumptions, but does not entirely clear up the matter as to the augmentation of transparency at a certain stage as observed by Keen and Porter. E. H. B.

1239. *Photometry of the Superficial Resonance of Sodium-vapour.* **L. Dunoyer** and **R. W. Wood.** (Comptes Rendus, 158. pp. 1068–1071, April 14, 1914. Le Radium, 2. pp. 111–118, April, 1914.)—This paper deals with measurements that have been made of the way in which the intensity of the surface resonance of sodium vapour varies with the intensity of the salt flame used for excitation. The measurements have revealed the max. luminescence of the molecular resonators, and, further, have given approximately the width of the resonance D-lines. The experimental arrangement for producing the surface resonance was the same as that used in the preliminary investigation [Abstract No. 859 (1914)]. The photometric method consisted in comparing the intensity of the surface resonance with that of a white, matt layer of magnesia deposited on the wall of the bulb containing the sodium-vapour, this layer receiving the same illumination as the vapour showing surface resonance. All measurements were taken at a temperature of about 880° C. The observations confirm the fact previously noted by Wood for mercury-vapour and by Dunoyer for sodium-vapour, that the resonance lines should be much finer than the exciting lines [Abstract No. 801 (1913)]. Making use of some measurements of Fabry and Buisson it is calculated that the width of the resonance lines in the conditions dealt with is of the order of 0·08 Å. unit. A. W.

1240. *Photometry of the Superficial Resonance of Sodium-vapour.* **L. Dunoyer** and **R. W. Wood.** (Comptes Rendus, 158. pp. 1265–1267, May 4, 1914. Le Radium, 2. pp. 119–128, April, 1914. Phil. Mag. 27. pp. 1025–1035, June, 1914.)—In a previous paper [see preceding Abstract] a calculation was made of the width of the lines emitted by the surface resonance of sodium vapour under the excitation of the sodium D-light. The calculation was based on the incorrect formula $y = Ce^{-kx}$ for the partition of energy in a spectral line, x being the distance, in wave-lengths, from the centre of the line to the point where the intensity is y. The correct formula, due to Fabry and Buisson [Abstract No. 1190 (1912)], is $y = Ce^{-kx^2}$. Applying this formula to the results obtained, and using some of the results of Fabry and Buisson, it is found that the resonance lines are nearly four times narrower than the exciting lines. Assuming the value 0·04 Å. unit for the half-width of the D-lines emitted by a flame very poor in sodium, the width of the resonance lines becomes 0·0216 Å. unit, instead of 0·082 Å. unit as previously found. Thus we have here spectral lines a little narrower than the spectrometric standards furnished by the iron arc, though they are still about three times the width of the finest lines, such as the red line of cadmium.

A. W.

1241. *Interferometric Wave-length Measurements in the Infra-red.* **A. Ignatieff.** (Ann. d. Physik, 43. 8. pp. 1117–1136, April 16, 1914.)—Wave-length measurements by the interference method have so far only been attempted in the infra-red up to 8824 Å. The paper describes in very full detail arrangements for extending such measurements to lower regions and for examining the purity of infra-red lines. In particular the He lines 10830 and 20581 and the Cd line 10394 Å. are investigated, and it is found that of these lines the 10,830 Å. line alone is double. The wave-length of the auxiliary line is smaller than that of the chief component and for the perpendicular and end-on positions of the capillary tube the intensities are respectively 1 : 5 and 3 : 4.

C. S. G.

1242. *Measurement of Standard Wave-lengths in the Infra-red* **H. Werner.** (Ann. d. Physik, 44. 2. pp. 289–296, May 12, 1914. Extract of Dissertation, Tübingen.)—The lines of the vacuum arc spectrum of barium between 5971 and 7911 Å. are measured in international units, using as standard the Fe line 6494·993 Å. The arrangement employed consists in first forming Haidinger rings by passing the rays through a Hilger étalon. By means of a plane and a concave mirror the rays are then passed through the slit, analysed by a grating and photographed. Corrections are applied to the measurements for the difference in the focal lengths of the grating and the concave mirror, temperature-changes and the change of phase at the reflecting surfaces. An accuracy of about 0·002 Å. is obtained. The lines at 6141 and 6496 Å. do not appear to possess satellites, as previously supposed, but instead exhibit slight reversal at their centres. On the other hand, the lines at 7195 and 7392 are undoubtedly composite.

C. S. G.

1243. *Series in the Spectra of Indium and Gallium.* **F. Paschen** and **K. Meissner.** (Ann d. Physik, 43. 8. pp. 1223–1226, April 16, 1914.)—A continuation of similar work on aluminium and thallium [see Abstract No. 1875 (1909)]. The measurements were made photographically and visually, both grating and prism apparatus being employed. Four principal series lines of indium are observed between λλ6900 and 4878 Å., and a formula is developed to which they are conformable. In the case of gallium, lines of the principal series and both the first and second auxiliary series are measured and the constants of the series formulæ are estimated from these measurements.

C. S. G.

1244. *Extension of the Spectrum in the Extreme Ultra-violet.* **T. Lyman.** (Nature, 93. p. 241, May 7, 1914.)—Schumann's researches led him to extend the spectrum to about λ1250. Lyman, using a concave grating, further extended it to λ1030, and has now succeeded in photographing the spectrum of hydrogen to λ905. It is characteristic of the region investigated by Schumann between λ1850 and λ1250 that, while hydrogen yields a rich secondary spectrum, with the possible exception of one line no radiation has been discovered belonging to the primary spectrum. On the other hand, in the new region between the limit set by fluorite and λ905, a disruptive discharge in hydrogen produces a primary spectrum of great interest made up of perhaps a dozen lines. These lines are always accompanied in pure hydrogen by members of the secondary spectrum, but they may be obtained alone if helium containing a trace of hydrogen is employed. Results obtained from vacuum tubes when a strong disruptive discharge is used must always be interpreted with caution, since the material torn from the tube itself sometimes furnishes impurities. In the present case, it will be some time before the effect of such impurities can be estimated. However, it may be stated with some degree of certainty that the diffuse series predicted in this region by Ritz has been discovered. The first member at λ1216 is found to be greatly intensified by the disruptive discharge, and the next line at λ1026 appears also, though very faintly. This diffuse series bears a simple relation to Balmer's formula. Following the same kind of argument, a sharp series corresponding to the Pickering series might be expected. The new region appears to yield two lines belonging to such a relation at the positions demanded by calculation. A. W.

1245. *Theory of the Electric Dispersion of the Hydrogen Lines.* **E. Gehrcke.** (Deutsch. Phys. Gesell., Verh. 16. 9. pp. 431–435, May 15, 1914.)—The theory of the electric dispersion of the hydrogen lines has been considered by Warburg and by Garbasso [Abstracts Nos. 460, 667 (1914)], also by Gehrcke and Bohr. The formulæ deduced for the magnitude of the separation are respectively $\delta\lambda = \pm hp^2\lambda^2 F/4\pi^2 cme$...(1), $\delta\lambda = \pm 3h(p^2 - q^2)\lambda^2 F/4\pi^2 cme$...(2), $\delta\lambda = \pm h(p^2 - q^2)\lambda^2 F/2\pi^2 cme$...(3), $\delta\lambda = \pm 3h(p^2 - q^2)\lambda^2 F/8\pi^2 cme$...(4). In the present paper these four formulæ are discussed. The formulæ are similar in many respects, but do not give the same results for the dependence of $\delta\lambda$ on the wave-length. Taking the formula $\nu = \nu_0[1/q^2 - 1/p^2]$ for the Balmer series, it follows that $p^2 - q^2 = \lambda_\infty \cdot q^2p^2/\lambda$, where λ_∞ denotes the wave-length of the end of the series. Taking $q = 2$, each of the formulæ (2) to (4) gives an expression of the form $\delta\lambda = \pm$ const. $p^2\lambda$...(5), while formula (1) gives $\delta\lambda = \pm$ const. $p^2\lambda^2$...(6). The results of Wilsar [Gesell. Wiss. Göttingen, Ber., 1914], and of Stark and Kirschbaum [Abstract No. 1071 (1914)], though showing slight discrepancies, are represented very much better by a formula of type (5) than by one of type (6). A discussion of the experimental results shows that they can be generally explained by the author's model atom, as regards the magnitude of the separation of the inner and outer components and their dependence on the field strength and series number, as well as the polarisation and intensity ratios of the components and the asymmetry of the separation. A. W.

1246. *Atomic Structure and High-frequency Spectra.* **J. W. Nicholson.** (Phil. Mag. 27. pp. 541–564, April, 1914.)—Moseley's remarkable experimental results [Abstract No. 467 (1914)] give a new order of simplicity to the determination of wave-lengths of the characteristic Röntgen radiation from metals. They indicate a definite law which appears to connect successive elements in the Periodic Table; and the author suggests that "they supply perhaps the most hopeful way of obtaining a more intimate knowledge of the inner structure of the atom, and of the essential relations between the various elements." Moseley interprets his results in terms of Bohr's theory and the author shows that the interpretation is open to criticism in some of its details. In the first place he arrives at the conclusions from general mathematical considerations which he promises to amplify in a further paper, and from the detailed examination of the configuration suggested by Bohr for the lithium atom, that an atomic Saturnian system, consisting of concentric coplanar rings of electrons rotating about a central positive nucleus, is a practical impossibility even according to Bohr's theory, as in order to retain the coplanar rings which he assumes we should have to depart from dynamics even more completely than he has, and admit the possibility of an uncompensated force of electrostatic type producing no corresponding acceleration, or else change the laws of force between electrons altogether, while preserving them as between electron and nucleus. According to ordinary electrodynamics coplanar rings are mathematically impossible; and we cannot retain Bohr's theory of the more complex atoms, and van den Broek's hypothesis in its present form simultaneously. According to this hypothesis, the atomic number of an element, *i.e.* the electron-equivalent of the positive nucleus of the atom, corresponds exactly to its position in the Table as we know it. There is no conflict in the case of H and He, but for the more complex atoms, if Bohr's theory is to be retained, the hypothesis must be modified by allowing the atomic number to be different from the position in the Periodic Table. Substituting non-coplanar for coplanar rings, and so modifying van den Broek's hypothesis, Bohr's theory of the more complex atoms can apparently continue to represent the facts for at least some distance in its development. Moseley's interpretation of his results is vitiated by an error, the omission of the factor n from the formula, in the usual notation, derived from Bohr's theory giving the frequency emitted between two stationary states by a ring in which every electron has angular momentum $R\tau h_0 2\pi$, angular velocity ω, and radius a, viz.—

$$\gamma = 2\pi^2 m e^4/h^3 \,.\, n(N - S_n/4)^2(\tau_1^{-2} - \tau_2^{-2}).$$

Therefore, as far as yet discussed, Moseley's observations have shown no relations to Bohr's theory, and the author considers that what he has really shown is that the frequencies of the principal Röntgen rays of the elements are proportional to the squares of natural numbers, a remarkable result which must lead to further knowledge of atomic structure. G. W. DE T.

1247. *Bohr's Theory and Hydrogen and Helium Spectra.* **J. W. Nicholson.** (Roy. Astronom. Soc., M.N. 74. pp. 425–442, March, 1914.)—According to Bohr's theory, the line λ4686 of nebulae and Wolf-Rayet stars, together with Pickering's series, hitherto ascribed to H, and the recent series of Fowler, are due to He with a single positive charge arising during the formation of a charged atom from a single positive nucleus and an approaching electron. If these lines therefore are, as in the average Wolf-Rayet star, much stronger than ordinary He lines, the majority of the He atoms should apparently be repeatedly in a state of being deprived of all their electrons. Hence, either electrons are scarce in the nebulæ and such stars, and they must have considerable positive charges, or electrical agencies are at work strong enough to separate the atoms completely into their positive and negative components. Either supposition would be of fundamental import to the nature of these bodies, and of the Novæ. Some strong lines in the Wolf-Rayet stars are, moreover, attributed to lithium, and the same considerations apply, for there is no other evidence of its presence. The application of Bohr's theory to H can give no information on these points, H so easily losing its electrons, but it suggests an explanation of the fact that few Balmer lines are obtainable in the laboratory, while over thirty are visible in the chromosphere spectrum, because Bohr suggests that the tenuous solar atmosphere allows the atoms to expand to a large multiple of their normal size. This is contrary to evidence mainly derived from spectrum line displacements tending to show presence of regions of considerable pressure in the chromosphere, but Evershed, in a recent Bulletin of the Kodaikánal Observatory, has given serious reasons for doubting the existence of such pressures. J. J. Thomson's photography of *positive rays* gives continuous evidence of He-atoms with one positive charge, but only rarely with two charges. The latter, according to Rutherford's theory, as well as Bohr's, are simply α-particles. It appears then, difficult to remove two electrons from the He atom. Yet this must have been done, according to Bohr's theory, in Fowler's tubes showing the line $\lambda 4686$ strongly. And Evans has confirmed his results [Abstract No. 225 (1914)]. If such tubes were examined by Thomson's method a decisive criterion of Bohr's theory would be obtained, confirming it if positive ions, with an "electric atomic weight" equal to 2 were found more strongly than usual, and disproving it if the result were negative.

The Balmer series does not give the main part of the ordinary terrestrial spectrum of H, the so-called secondary spectrum being at last admitted to be a true H-spectrum, and is attributed to molecules, perhaps H_3, as shown to exist by J. J. Thomson, as well as H_2. Part of this secondary spectrum shows Zeeman-effect, part not, and the former is generally, if not entirely, absent from astronomical spectra. Probably this part is due to negatively charged H-atoms largely present in vacuum tubes. If so, the consequent absence of negatively charged H-atoms from astronomical spectra is of much import. This would lead to the conclusion, *e.g.* that the chromosphere, in which H is abundant, must be positively charged, for the radiation is strong, involving, on any theory of spectra, a continuous interchange of electrons, so that if neutral, many negatively charged H-atoms would always be present. This is noteworthy in view of the fact, proved in former papers, that the corona has a large negative charge. For it would seem that the corona consists of negatively charged atoms shot off, perhaps by a process of radioactivity, from the chromospheric atom, which would leave a positive charge in the chromosphere.

The author shows by a detailed mathematical investigation that the secondary and H spectrum cannot be accounted for on Bohr's theory as (1) due to the atom, charged or neutral; (2) the spectrum of the molecules, when neutral; (3) arising during the transition from the molecular to the atomic state; and that, in fact, Bohr's theory cannot explain any portion of the H-spectrum except the Balmer and Ritz series, and perhaps a Schumann series. Further, the theory gives rise to nothing analogous to the ordinary He spectrum, for, on investigation of the simplest stationary states, the resulting spectrum is quite unknown. And the author states that a more complete investigation of all the stationary states has been equally unsuccessful.

In all the cases examined the expressions for the frequencies of the emitted radiation assume the form $\gamma = A(\tau_1^{-2} - \tau_2^{-2})$, where the constant A varies considerably, and though always containing, as a factor, the Rydberg constant, which Bohr identifies with $2\pi^2me^4/h^3$, the other factors have no simple general form. In fact, Rydberg's constant, as a universal constant of spectra, is not preserved, and Bohr's theory can proceed only by the further deviations from ordinary dynamics indicated in the preceding abstract. [See also Abstract No. 1040 (1914).] G. W. DE T.

1248. *Arc and Spark Spectra of Strontium.* **H. Hampe.** (Zeitschr. wiss. Phot. 13. pp. 348–368, April, 1914.)—Describes measurements of the wave-lengths of the lines of the arc and spark spectra of strontium. The Rowland grating of Bonn University, 6·34 in. radius and 20,000 lines to the inch, was employed. The results, in international units to three decimal places, are tabulated, and some lines are arranged in series. Three triplet series are noted. The members of the first subordinate series of triplets possess satellites. The first line of the triplets has two, and the second one satellite; the third line is simple. Numbering these lines and satellites 1–6, it is found that 1 and 4, as well as 2 and 5 have the same frequency-difference 394·2; 4 and 6 have a smaller frequency-difference 186·8. Only two triplets of the second subordinate series are given. A single triplet is given which does not appear to belong to the subordinate series, but has the same frequency-differences, 394·2 and 186·8. Two pairs of lines are given with the frequency-difference 394·2. Three pairs of lines show the double difference 801·4. Other triplet series are given characterised by the smaller frequency-differences 100·5 and 59·7. A. W.

1249. *High-frequency Spectra of the Elements.* II. **H. G. J. Moseley.** (Phil. Mag. 27. pp. 703–713, April, 1914.)—Part I. of this paper dealt with a method of photographing X-ray spectra, and included the spectra of a dozen elements [Abstract No. 467 (1914)]. More than thirty other elements have now been investigated, and simple laws have been found which govern the results, and make it possible to predict with confidence the position of the principal lines in the spectrum of any element from Al to Au. The general experimental method was the same as in the earlier work, the same crystal of potassium ferrocyanide being used as analyser throughout. Since the radiations of long wave-length cannot penetrate an Al window or more than a few cm. of air, the photographs in this case had to be taken inside an exhausted spectrometer, a description of which is given. A window of goldbeater's skin allowed the radiation to enter the spectrometer, this substance being extremely transparent to X-rays and being capable, if left undisturbed, of withstanding the pressure of the atmosphere. The results of the investigation may be summarised as follows:—(1) Every element from aluminium to gold is characterised by an integer N which determines its X-ray spectrum. Every detail in the spectrum of an element can therefore be predicted from the spectra of its neighbours. (2) This integer N, the atomic number of the element, is identified with the number of positive units of electricity contained in the atomic nucleus. (3) The atomic numbers for all elements from Al to Au have been tabulated on the assumption that N for Al is 13. (4) The order of the atomic numbers is the same as that of the atomic weights, except where the latter disagrees with the order of the chemical properties. (5) Known elements correspond with all the numbers between 13 and 79 except three. There are here three possible elements still undiscovered. (6) The frequency of any line in the X-ray spectrum is approximately proportional to $A(N - b)^2$, where A and b are constants. A. W.

1250. *Ratio of the Intensities of the D-Lines of Sodium.* **R. W. Wood.** (Phys. Zeitschr. 15. pp. 382–383, April 15, 1914.)—Many measurements of the intensity ratio of the Na D-lines have been made. Brotherus has shown [Abstract No. 1358 (1912)] that the ratio varies with the quantity of sodium present in the flame. The highest value obtained by him was $D_2/D_1 = 1·5$ and the lowest 1·3. Using a flame very poor in sodium, Wood now finds that the ratio may be as much as 3 or more. A Méker burner was used, coloured only by the sodium present in the air of the room, the air having previously passed through a second Méker burner, on whose grid was placed a stick of NaCl impregnated with sodium. A large constant-deviation spectrograph was employed and five exposures were made, of 1, 2, 3, 4 and 5 minutes' duration respectively, all on one plate. It was found that the intensity of the D_1 line for the 4-minute exposure was only slightly greater than that of the D_2 line for 1 minute, while the 3-minute D_1 line was certainly less intense than the D_2 1-minute line. This means that the D_2 line is between 3 and 4 times as intense as the D_1 line, the intensity ratio being probably about 3·75. Experiments with a flame rich in sodium showed that the intensity of both lines was very nearly the same. A. W.

1251. *Absorbing Power of the Arc for its own Radiations.* **G. Gouy.** (Comptes Rendus, 158. pp. 1057–1060, April 14, 1914.)—The visible rays from an impregnated carbon arc are dispersed by a grating and examined ocularly on a screen alongside a continuous spectrum formed by an auxiliary collimator carrying two nicols. The continuous spectrum can thus be matched with the arc spectrum. The intensity I of the direct beam is measured, and by means of a mirror arranged at the back of the arc a beam is reflected through the arc and the intensity I' again measured. If K is the fraction of the light intensity transmitted by the direct and reflected rays, $2K$ is the absorbing power and $K = 1 + 1/R(I'/I - 1)$, where R is the reflecting power of the mirror.

In particular the rays of calcium between 5188·9 and 6462·2 Å. and of strontium between 4607·3 and 5486·2 Å. have been examined and the value of $2K$ varies from 0·11 to 0·64. The absorbing fraction lies between 0·5 and 0·7 for the more intense rays but is smaller for the feebler ones. Regarding each ray as the maximum of a continuous function decreasing on either side of the spectrum, and therefore containing rays for which the absorbing power is small, it will be seen that the absorption of the principal ray must necessarily remain inferior to unity. C. S. G.

1252. *Complex Structure of Spectrum Lines.* **C. Wali-Mohammad.** (Astrophys. Journ. 39. pp. 185–208, April, 1914.)—The spectra of fifteen metals have been examined, using an echelon grating and a monochromator. Photographic measurements are obtained conveniently with short exposures by employing the oxy-kathode source and the readings taken with a Zeiss microscope. Most of the lines are simple and none of the metals show the same abundance and complexity of satellites as mercury. Some of the lines exhibit symmetrical, while others show unsymmetrical, self-reversal. In a few cases it is shown that lines previously thought to be satelites are to be attributed to such reversals. C. S. G.

1253. *Differences in the Polar Spectra of Various Elements.* **B. Reismann.** (Zeitschr. wiss. Phot. 13. pp. 269–311, March, 1914.)—The spectra exhibited at the different locations in a Geissler tube are photographically examined for the following elements and compounds: chlorine, bromine, iodine, hydrogen, oxygen and nitrogen; the vapours of Bi, Sb, Cd, Zn, Hg, Ag, and Pb; carbon monoxide, hydrochloric acid, carbon tetrachloride and stannic chloride; and, in general, differences are observed in the spectra at the poles and in the positive column. The halogens show line spectra at the kathode only, which correspond generally to the spark spectra of the elements, but otherwise continuous spectra are obtained. For the halides the results correspond to those of Stead [Abstract No. 1488 (1911)]. Oxygen shows only the series spectrum in the positive column; at the kathode, however, the series, the elementary line and the band spectra appear. Nitrogen is characterised by an especially marked negative band spectrum at the anode, whilst in hydrogen differences in intensity only are observed at the two poles. The metallic vapours all give band spectra throughout the tube, but whilst the arc lines appear throughout, the spark lines seem only to occur at the kathode. Carbon monoxide when present as an impurity seems to be concentrated in the positive column. C. S. G.

1254. *New Ultra-violet Absorption Spectrum of Oxygen.* **L. and E. Bloch.** (Comptes Rendus, 158. pp. 1161–1164, April 27, 1914. Le Radium, 2. pp. 97–100, April, 1914.)—By making long-exposure (up to 6 hours) short wave-length spectrograms of the spark spectra of Bi, Al, Cd, Sn, and Tl, and of the positive crater of the carbon arc it is found that certain dark bands of lines appear, which are constant in position and appearance, although the relative intensities of the lines vary for the different light sources. These bands are attributed to the absorption of the oxygen of the air from the continuous spectra, which for different sources have different intensities. Steubing [see Abstracts Nos. 64 (1911), and 599 (1913)] has attributed the light spaces between these lines to short-waved fluorescence of oxygen, but the authors have failed to obtain any indication of such fluorescence, using a quartz mercury lamp and exposing for 8 hours. To the five bands observed by Steubing between 1831 and 1919 Å. two new bands at 1928·4–1936·5 and 1946·5–1957·4 Å. have been added. The bands, both old and new, have the same structure and conform to a Deslandres' formula, for which the constants are obtained. C. S. G.

1255. *Combined Effect of Electric and Magnetic Fields on Spectrum Lines.* **J. Stark.** (Deutsch. Phys. Gesell., Verh. 16. 7. pp. 327–332, April 15, 1914.)—The helium line λ4471·646 was found by Lohmann [Abstract No. 617 (1908)] to yield a normal Zeeman triplet in the transverse effect; but when subject to an electric field of from 20,000 to 30,000 volts/cm. the line gives a quartet with two components oscillating parallel to the field and two perpendicular to it. Two cases of the transverse effect occur with superimposed electric and magnetic fields: (1) Electric and magnetic fields parallel to one another. The question then arises as to whether in this case the two electric components of the line oscillating perpendicular to the electric field are each separated into a doublet by the magnetic field, while the two components oscillating parallel to the electric field remain unaffected, or does another kind of electromagnetic separation take place. (2) Electric and magnetic fields perpendicular to one another. Do the two electric components oscillating parallel to the electric field each split up into a doublet under the action of the magnetic field, the two perpendicular components remaining unaffected, or does another type of separation occur here? Experiments are being undertaken with a view to elucidating these problems. It was found that by the admission of a certain amount of hydrogen to the helium in the discharge tube the light emission of the canal rays in the mixture is more intense than in pure He. A description is given, with diagrams, of the apparatus to be used for investigating the combined effect of the electric and magnetic fields. The results of the experiments will be published later. [See Abstract No. 288 (1914).] A. W.

1256. *Lithium Doublets and Effect of Magnetic Field.* **N. A. Kent.** (Phys. Zeitschr. 15. pp. 383-385, April 15, 1914.)—In continuation of the work of Paschen and Back on doublet and triplet series [see Abstracts Nos. 419, 1282 (1913)] a study was made of the lithium line λ6708·2 found by Zeeman in the absorption spectrum to be a double line with the wave-length difference 0·144 Å. unit. The research showed that the four lines λ6708·2, λ6103·77, λ4972·11, λ4602·87 are members of a doublet series and correspond to the doublets of the other alkali metals, the wave-length differences being respectively 0·151, 0·114, 0·084, and 0·069 Å. unit. In high fields the lines give normal Zeeman triplets, as was previously found by Back, who used the spark in air as the source of light. The sources of light used in the present experiments were a Geissler tube and a vacuum arc-lamp. A. W.

1257. *Zeeman-effect for Series Lines.* **W. Voigt.** (Ann. d. Physik, 43. 8. pp. 1137-1164, April 16, 1914.)—A theoretical treatment referring specially to the sodium doublets and the oxygen triplets λ3947. A general coupling theory is discussed. [See also Abstracts Nos. 1440 and 1826 (1913).] A. W.

1258. *Light Absorption and Fluorescence.* **E. C. C. Baly.** (Phil. Mag. 27. pp. 632-648, April, 1914.)—It has previously been shown that it is possible for one substance to exhibit different absorption bands when dissolved in different solvents. If, for example, certain aromatic amino aldehydes and ketones are dissolved in alcohol their solutions exhibit characteristic absorption bands in the ultra-violet region. If now to these alcoholic solutions a small quantity of an alcoholic solution of HCl is added, the quantity being much less than is required to convert the whole of the amino compound into the hydrochloride, a second absorption band is developed of longer wave-length. The addition of a further quantity of HCl changes the absorption to that characteristic of the hydrochloride of the base. An exactly similar phenomenon was observed in the case of the sulphonation of certain benzene compounds. The fact that more than one absorption band is given by one and the same substance in different solvents gives at once a reasonable explanation of phosphorescence and fluorescence. The various absorption bands exhibited by the same substance represent various free periods of vibration possessed by the same substance. If now a substance in alcoholic solution exhibits an absorption band, and if it is absorbing light of this frequency, it is reasonable to expect that some of the vibrations corresponding to greater stages in the opening up of the closed force field of the atoms are brought into play, and hence the substance will fluoresce with emission of light of wave-length corresponding to the more opened-up phases. The wave-length of the light absorbed by a substance when opened up to a greater stage by solution in a suitable solvent should therefore be the same as the fluorescent light emitted in alcoholic solution when it is only opened up to a lower stage. This has actually been found to be the case, for the fluorescent light emitted by a number of compounds in alcoholic solution is the same as that absorbed by them when in solution in sulphuric acid. Similarly the wave-length of the fluorescent light emitted by the alcoholic solutions of the amino aldehydes and ketones is the same as that absorbed by them in the presence of traces of HCl. It follows from this that the fluorescent spectrum of a compound will give a measure of a wave-length of the absorption band of that substance when opened up to a greater stage. Only a few substances have been found up to the present in which more than two absorption and fluorescent maxima have been measured, but in each of these there exists a constant frequency-difference between these maxima. A large number of compounds, for which only two maxima of absorption and fluorescence are known, show a frequency-difference of 400 or some multiple of 400. Further research on these lines is in progress. An explanation of this is suggested, based on the quantum theory. Further experimental verification may be sought in the refractivities of compounds, which Sellmeyer has shown can be connected with an absorption band in the ultra-violet. The refractivities of Cl, HCl, water-vapour, NH_3, N_2O_3, and N_2O have recently been given by C. and M. Cuthbertson [Abstract No. **1642** (1913)], and their values are found to be in good agreement with those calculated from a modified form of Sellmeyer's formula, use being made of the wave-lengths of the infra-red absorption bands of the different substances. The existence of absorption bands and fluorescence maxima with constant frequency-differences and the results of the above calculations seem to show fairly conclusively that the application of the quantum theory to absorption spectra observations is thoroughly justified. Many interesting deductions may be made from this application. Thus, since it would seem that phosphorescence and fluorescence only differ in the relative velocity and absorption of the energy, and since the emission of infra-red radiation appears to be intimately connected with absorption in the ultra-violet, it is to be expected that the converse would be true. This may give an explanation of the well-known fact that the phosphorescence of a substance after exposure to an exciting cause is at once destroyed on exposure to infra-red radiation. Also, since refractivity and magnetic rotation are bound up with chemical structure, it should be found possible on the above grounds to connect these properties with absorption and constitution more intimately than has hitherto been found possible. A. W.

1259. *Decay of the Luminescence of Coloured Gelatine.* **A. Pospielow.** (Deutsch. Phys. Gesell., Verh. 16. 9. pp. 411–420, May 15, 1914.)—By means of a phosphoroscope of the Wiedemann type used in conjunction with a spectrophotometer the intensity of the green band in the spectrum of the phosphorescent light emitted by gelatine coloured with eosin was determined at various intervals after its illumination with light from an arc. The gelatine was prepared in the form of thin films adhering to glass surfaces. The intensity of the emitted light was found to be an exponential function of the time. Films suspended in an atmosphere of water-vapour gave much larger decay coefficients than films which had been carefully dried. F. J. H.

1260. *Asymmetric Distribution of Secondary Electronic Radiation produced by X-radiation.* **A. J. Philpot.** (Phys. Soc., Proc. 26. pp. 181–186, Feb., 1914.)—It has been found by several investigators that the amounts of electronic radiation given off on the two sides of a sheet of metal, exposed to a beam of X-rays, incident normally upon it, are not equal, but that, when due allowance has been made for the absorption of the X-radiation in the sheet itself, there is a preponderance of electronic radiation emitted in the original direction of propagation of the X-radiation. There is, however, a disagreement amongst various observers as to the extent of this asymmetry.

In the present investigation an attempt is made to arrive at more definite results. The radiations used had mass absorption coefficients in aluminium ranging from 0·5 to 5·0. The values obtained for the ratio of the emergent to the incident electronic radiations were found not to differ much from the value 1·18 arrived at by Cooksey [see Abstract No. 1585 (1912)], but in general an increase of hardness of the exciting X-radiation was found to correspond with an increase of asymmetry. Such increase, however, was very slight compared with the increase in penetrating power of the exciting radiation.

E. A. O.

1261. *Röntgen Patterns of Boracite, obtained above and below its Inversion Point.* **H. Haga** and **F. M. Jaeger.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 792–799, March 26, 1914.)—It is attempted to find whether with polymorphic changes, principally in cases of enantiotropic inversions in the neighbourhood of the critical inversion temperature, a change of molecular arrangement takes place or whether the cause of polymorphism is to be attributed to a change in the crystal molecules themselves. The problem is investigated in the case of boracite, which is a crystal whose optical behaviour does not agree with the symmetry of its external form, its cohesion, etc., or in other words, its total crystallographic character. Boracite crystallises in forms, which, even by the most accurate goniometrical measurements, cannot be discerned from real hexakistetrāedrical ones, whilst optical investigations, and also those concerning the corrosion phenomena, have definitely shown that crystals of boracite possess no regular symmetry in the ordinary way. At temperatures between 260° and 280° C. boracite suddenly becomes optically isotropous, and its optical properties are now in complete agreement with its external form. On cooling, the birefringence returns and the crystal resumes the case of an optically anomalous one. The crystal is investigated in the present instance by sending a beam of X-rays through it and photographing the pattern of it in the usual way. A detailed account is given of the furnace in which the crystal was heated. It was so arranged that a beam of X-rays could traverse the crystal at very high temperatures as well as at ordinary room temperatures. Experiments were only made with a plate of the crystal cut perpendicular to the binary axis, and if the crystal were really of a regular system such a plate must at the same time be also perpendicular to the quaternary axis. Laue photographs were taken of the crystal at room temperature and at about 300° C.; at this temperature the optically isotropous form was always present. It was found that there was a difference between the Laue patterns at these two temperatures, which indicates that, by heating to 300° C., there is a slight molecular rearrangement in the boracite crystal, and from this it is to be inferred that the dimorphism of the boracite is connected with a change in its molecular arrangement. Similar experiments with leucite are in progress. E. A. O.

1262. *Röntgen-ray Reflection.* II. **C. G. Darwin.** (Phil. Mag. 27. pp. 675–690, April, 1914.)—In the former paper [Abstract No. 1082 (1914)] formulæ were obtained for the intensity of reflection by a crystal without taking account of the interaction of the atomic vibrations. This is here allowed for, and plane waves are assumed owing to the complexity of the problem, and justified by the observation that it is only necessary to find the amplitude of reflection at a point so distant from the crystal that in the principal part of the field the phases of waves from adjacent atoms are sensibly the same. This permits the summation to be replaced by an integration, while yet the point is not so distant that the crystal has to be regarded as finite; this introduces the Fresnel factors in the integral and makes it converge. Though not mathematically rigorous, there can be little doubt of the right value being so obtained, and it has the advantage that the formulæ do not involve the exact number of atoms in the whole plane, which is clearly irrelevant to the final results. The result of the interaction is an effect like that of an addition to the radiation term in the vibration of an electron. Now the radiation term scarcely affects the amplitude of an electron vibrating under the influence of Röntgen rays, so we may conclude that the mutual influence of atoms on a plane may be neglected, as might also be expected from the complete absence of phase relations of waves arriving at any one atom from the rest. Not so, however, for a combination of all planes. Then, when the radiation is at the angle of reflection, the waves reflected from successive planes are in same phase and should therefore give rise to a secondary reflection, and this is what was neglected in the first paper. Modified formulæ are now obtained giving practically perfect reflection within a certain angular range, and consequently a more rapid extinction of the transmitted beam than corresponds to the true absorption of the crystal. The new formulæ make the reflection independent of the absorption coefficient of the crystal, and Bragg [Abstract No. 672 (1914)] has proved that absorption plays an important part. The author seeks an explanation in the imperfections of a crystal, and when the effect of the irregularities to be expected is taken into account, the formulæ obtained differ from those of the first paper by a numerical factor only, and are taken by the author as the best approximation as yet obtainable. G. W. DE T.

1263. *New Method of rapidly obtaining Spectra of Röntgen Rays.* **M. de Broglie** and **F. A. Lindemann.** (Comptes Rendus, 158. p. 944, March 30, 1914.)—A beam of X-rays, coming from a slit, falls on a sheet of mica rolled on a fixed cylinder, whose axis is parallel to the slit. It is so arranged that the extreme rays on one side of the beam fall tangentially on the surface of the cylinder. The different rays in the beam are reflected at different angles and register themselves in different positions on a photographic plate. The whole spectrum of the rays in the beam can be photographed in a few minutes by this method. E. A. O.

1264. *Measurements of Intensity and Hardness of Röntgen Rays.* **H. Kröncke.** (Ann. d. Physik, 43. 5. pp. 687–724, March 13, 1914. Extract from Dissertation, Göttingen.)—The hardness of a beam of X-rays is generally measured by means of the simple formula $I = I_0 e^{-\lambda x}$, where λ is the coefficient of absorption of the rays. In practice, λ is given for a thickness of 1 cm. of a standard substance, whether this be the thickness of the layer used in the experiment or not. The author points out that there is a serious error introduced unless the coefficient of absorption is given in terms of the thickness actually employed in the measurement. The aim of the present investigation was to find how the hardness and intensity of X-rays could be defined in a manner free from this objection. With this in view, attention is given to the measurement of the voltage and current through the tube, and it was found that an exact measurement of these two quantities was sufficient to determine the hardness and intensity. Hence the chief aim of the work resolves itself into finding the relations which exist between the voltage and the current in the tube and the hardness and intensity of the rays.

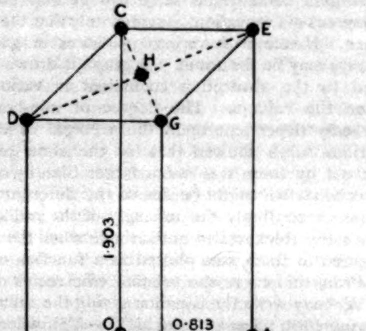
The tube was driven by means of a constant continuous current which was obtained by Des Coudres' method of producing high-voltage continuous currents, but this method was improved upon by the use of a resonance transformer. Six different tubes were used in the investigation—some were water-cooled and fitted with carbon regulators, others were regulated by an arrangement similar to the Bauer valve. In the latter case a piece of glass tubing was fused into the wall of the X-ray tube, into which a small piece of clay was fitted. The whole was covered with mercury, which was held in a rubber tube passing over glass tubing. The clay allows air to pass through it, but not Hg. If the vacuum gets too low, a pressure is applied to the rubber tubing which makes it expand, thus lowering the mercury surface and exposing the clay to the air, which enters into the tube. This regulator proved invaluable throughout the work. Oscillograms showed that the current through the tubes was remarkably constant. Any degree of hardness of the tube could be established and reproduced at any time.

According to Simon, the characteristics of a tube may be divided into statical and dynamical: the former appearing with continuous current and the latter with non-continuous current. Characteristic curves showing the relation between the current passing through the tube and the voltage applied to it are given. When the tube is very soft the curve is nearly a straight line, except for very small values of the current. All the curves show a clear exciting minimum. After excitation, the voltage on the tube decreases and then gradually increases again. This behaviour of the characteristic curves was the same for all the tubes investigated. It was found that with hard bulbs the voltage on the tubes is only slightly dependent upon the current, and the hardness of the rays in this case would be almost independent of the voltage. It is pointed out that the initial potential required to light up the tube would be considerably lowered by warming the tube. The initial potential is also lower, the shorter the time since the last discharge of the tube. The flickering of an X-ray tube is to be explained by the fact that the voltage on the tube is almost roughly equal to the exciting voltage, so that it is not continuously above the "lighting up" point of the tube. This flickering can be removed by increasing the load, or, if this is impossible, by making the tube softer.

Very careful measurements were made of the ionisation currents obtained with various tubes under different conditions. The readings of the ionisation currents were made in the shortest possible time, and, so far as could be arranged, under similar conditions in each case. It was found that the intensity of the radiation was directly proportional to the current through the tube. This was tested in the case of all the tubes investigated, and found to be true for a wide range of potential. Great difficulty was experienced in finding the relation between the potential on the tube and the intensity of the radiation—the reason for this chiefly being, that the exciting potential increases rapidly with the increasing hardness of the tube. It was found, however, with sufficient accuracy for all practical purposes, that the intensity of the radiation from an X-ray tube is a quadratic function of the voltage on the tube. The relation may be represented by the formula $S = A(V^2 - V_0^2)$, where V_0 is a constant for the tube and A, a function of the current passing through it. Since A is a linear function of the current *i*, we may write this $S = Ci(V^2 - V_0^2)$ where C and V_0 are constants for the tube. With low potentials this relation between the intensity of the radiation and the square of the potential does not hold. Incidentally, the formula is in agreement with that of Whiddington, which states that the energy of the radiation is proportional to the fourth power of the velocity of the kathode rays, the potential V being proportional to the square of the velocity of the kathode rays. The homogeneity of the rays emanating from a tube has been examined previously by Adams, but in the present investigation the matter was entered into more fully. Care was taken to measure the intensity of the radiation under constantly maintained conditions of discharge. In no case were the rays found to be homogeneous even though the kathode rays producing them were homogeneous. This is simply explained by the fact that some of the kathode rays are stopped more suddenly than others owing to the fact that they fall on the atom more centrally. Homogeneity of the rays is out of the question even after they have penetrated an Al plate of 6 mm. thickness and have thereby been weakened to less than 1 % of their original intensity. The distribution of the energy in an X-ray spectrum was investigated by plotting the intensity as a function of the hardness (as measured by the absorption coefficient of the rays), and a theoretical formula is obtained for the portion of the total radiation having a given hardness. By measuring the absorption coefficient of the rays in various thicknesses of Al when the current through the tube was altered, it was established that the hardness did not depend at all upon the current. This holds for voltages ranging from 15 to 40 kilovolts. It was also observed that the distribution of the rays in the spectrum was independent of the current in the tube. The hardness of the rays is completely defined by the voltage. The degree of the vacuum which exists in the tube, the construction of the tube, and like things are in themselves without influence on the hardness of the rays: they are only of secondary influence in so far as the voltage on the tube depends upon them. The same voltage may exist on a tube with quite different degrees of evacuation, provided only that the amount of current is suitably chosen. Hence, with various pressures of gas in the tube, the hardness of the rays may be the same. A graph is drawn showing how the hardness defined by the absorption coefficient in various thicknesses of Al depends upon the voltage. The degree of non-homogeneity of the rays is not markedly dependent upon the voltage. A comparison of the results with various tubes showed that for the same current the amount of energy given out by some was much larger than by others. It seemed probable that this behaviour might be due to the different thicknesses of the walls of the tubes. Accordingly the intensity of the radiation from various tubes having the same thickness of antikathode when the same current and voltage were applied to them, was plotted as a function of the thickness of the glass wall. From this curve the relative efficiencies of the tubes could be estimated. We may write the equation giving the intensity of the radiation in the following form: $S = k/r^2 . f(d) . i(V^2 - V_0^2)$, where k is the emissive power of the metal of the antikathode in the direction considered, r the distance between the ionisation chamber and antikathode, and $f(d)$ is a function of the thickness of the glass wall. If the intensity S were measured in absolute units, then by means of the above equation the emissive power of the antikathode in the particular direction chosen could be calculated in absolute units, since we know $f(d)$ from the curve. By comparison with the Benoist scale, it can perhaps be said that with a continuous current passing through the tube, rays of a medium hardness would correspond to a voltage of about 50 kilovolts, and hard rays to a voltage of about 80 to 100 kilovolts.

The investigation is extended so as to include the effect of X-rays on photographic plates. Up to the present we may summarise our knowledge on this point by saying that the blackening of a photographic plate under otherwise similar conditions is less, the harder the rays. In order to investigate quantitatively the action of the rays on photographic plates, the plates had to be exposed, developed, and finally measured under rigorously defined conditions. Schleussner's X-ray plates were used. The chief point in this connection was to maintain a well-defined condition of discharge in the X-ray tube for a considerable time. This was done by the method already alluded to; by careful manipulation of the air inlet valve, the variations of the voltage could be kept to within 6 %. A detailed account is given of the method of exposing and developing the plates, and of measuring the blackening produced. It was found that for Schleussner's X-ray plates the Bunsen-Roscoe law holds—namely, that equal photochemical actions correspond to equal amounts of energy. A graphical representation is given of the investigation of the problem of how the blackening of the plate by X-rays of constant intensity is dependent upon the voltage on the tube. It is finally pointed out how erroneous the measurements of hardness based on the measurements of photographic blackening can be. It is shown that the photographic measurements exhibit discrepancies up to 50 % compared with those found by the ionisation method. E. A. O.

1265. *X-ray Spectra given by Sulphur and Quartz.* **W. H. Bragg.** (Roy. Soc., Proc. Ser. A. 89. pp. 575–580, March 2, 1914.)—A number of results of examination of crystals by means of the X-ray spectrometer have recently been given by W. L. Bragg [Abstract No. 876 (1914).] The cases which he has considered are those in which the information has been sufficient for a complete solution of the crystal structure. The present note deals with two cases, viz. sulphur and quartz, which have not been completely solved but which have nevertheless given interesting results. The method employed consists in observing the angle at which X-rays of known wave-length are reflected from the faces of the crystal. The faces used are not necessarily natural faces but may be obtained by rubbing down, on sandpaper for instance, in directions suggested by general crystallographic evidence. The angles of reflection give the distance from plane to plane of atoms in the crystal, etc. [see Abstract No. 86 (1914)]. The sketch gives



the arrangement of the atoms in ordinary orthorhombic sulphur [$OB = 6{\cdot}40 \times 10^{-8}$ cm.]. The evidence shows that there are eight lattices similar to the one shown, and that these lattices interpenetrate each other. However, no data are available at present for proceeding further with the calculation of the relative positions of the eight lattices.

The structure of quartz is similarly dealt with. E. M.

1266. *X-ray Spectra.* **G. E. M. Jauncey.** (Nature, 93. p. 214, April 30, 1914.)—The author discusses some results of Herweg [Abstract No. 877 (1914)], who found that two lines in the X-ray spectrum of tungsten have almost the same wave-lengths as two of the lines of Pt. Assuming that X-ray spectra of different elements are similar and that corresponding wave-lengths are in the ratio of the squares of the atomic weights, it is deduced that the lines β and δ of Pt have nearly the same wave-lengths as the α and β lines respectively of tungsten, thus explaining Herweg's result. E. M.

1267. *Action of Radium Rays on Bakelite.* **C. E. S. Phillips.** (Nature, 93. p. 295, May 21, 1914.)—A disc 4·2 mm. thick of the light yellow variety of transparent bakelite was cut from a rod, polished and then radiated with β- and γ-rays from radium. The colour of the disc darkened to a wine-red after 3 days, and exhibited an absorption band $\lambda = 5700$–6000, which was not visible at first. The spectrum beyond $\lambda 4900$ Å. was also obliterated. The colouration extended to a depth of 2 mm., and it could be completely removed by exposure to a temperature of 100° C. for about 8 hours. The effect appears due to the direct action of the β-rays and the author suggests that the new substance may prove to be a useful filter for therapeutic use, especially as it is cleanly and easy to work. E. M.

1268. *Range of α-Particles in Air at Different Temperatures.* **A. F. Kovarik.** (Le Radium, 2. pp. 69–71, March, 1914.)—Polonium was used as source of α-particles, the ranges being determined at temperatures varying from 90° abs. to 362° abs. The method employed was that of Geiger and Nuttall [Abstract No. 163 (1912)] in which the source is placed at the centre of a large bulb, and a curve obtained connecting the ionisation current and the pressure of air inside the bulb. The curve shows a marked point of inflection at the pressure when the α-particles just fail to reach the walls of the bulb. From the radius of the bulb the range at atmospheric pressure can be deduced by assuming that range is universely proportional to the pressure. The results show that the range is practically proportional to the absolute temperature, as might have been anticipated from density considerations. E. M.

1269. *Numerical Determination of the Absorption and Reflection of β-Particles by Matter.* **A. F. Kovarik** and **L. W. McKeehan.** (Phys. Zeitschr. 15. pp. 434–440, May 1, 1914.)—The numbers of β-particles transmitted by sheets of Al and Sn of various thicknesses were determined by Geiger's method [Abstract No. 1878 (1913)], using RaE or the active deposit of thorium as source. In both cases the absorption was not according to an exponential law, the β-particles becoming more absorbable as the absorption proceeded. The β-rays reflected from various substances were also found to be numerically more absorbable than the primary rays. The number of β-particles reflected by thick sheets of matter of different elements was found to increase with the atomic weight (Al to Pb) in nearly the same manner as when measurements are made by the ionisation effect of the reflected rays. This shows that the decrease in velocity of β-particles by reflection is practically independent of the reflecting material. E. M.

1270. *Saturation-curve in Ionisation by α-Rays.* **G. Jaffé.** (Phys. Zeitschr. 15. pp. 353–360, April 1, 1914.)—The paper deals with further experiments to test the author's deductions regarding the saturation-curve in the case of ionisation by α-rays, the theory being based solely on the idea of columnar ionisation without any assumption of initial recombination. The α-particles investigated were canalised very carefully, and uniform electric fields used. The results show that the "columnar ionisation" theory is satisfied accurately for air with fields parallel to the ionisation columns and with various distances between the electrodes. [See Abstracts Nos. 821, 712 (1914).] E. M.

1271. *Absorption of γ-Rays.* **S. Oba.** (Phil. Mag. 27. pp. 601–607, April, 1914.)—The object of the present experiments was to investigate whether or not γ-rays are changed in their quality by passing through matter. For this purpose the absorption by Al and Fe was determined both for the primary γ-rays of Ra and for the rays after passage through different thicknesses of "hardening" materials such as Cu, Sn, and Pb, since it is known that these metals apparently decrease the absorption coefficient in Al of γ-rays which have passed through them. The results may be summarised as follows:—(1) The absorption coefficient in Al for the primary γ-rays decreases gradually with increasing thickness up to 6·6 cm. Al and is then practically constant up to 16 cm. ($\mu/\rho = 0{\cdot}0428$), while that in Fe continually decreases with increasing thickness. (2) The material through which γ-rays were first passed acts in all cases to harden the rays. (3) The decrease of the value of μ/ρ [*i.e.* (2)] becomes more pronounced for larger thicknesses of the absorber, but the decrease appears to tend to a limiting value. (4) The γ-rays which have been hardened become gradually softer by passing through increased thickness of absorber. Moreover, particularly in the case of Fe, it is possible that the hardened γ-rays may tend, with large thickness of absorber to the same penetrating power as that to which the primary γ-rays tend. The author considers the results as due to excited γ-rays in the absorption sheets, *i.e.* a transformation of part of the original γ-rays. Such excited rays will be in all cases softer than the rays producing them, and the issuing rays will reach a state of equilibrium when the proportion of primary rays and of softer excited rays has a certain definite value. In the case of Al as absorber, for example, when the rays have previously passed through a hardener of high atomic weight they will have been robbed of the greater part of the softer constituents, so that as they pass through the Al, more and more soft radiation will be excited until equilibrium is established. The rays will therefore apparently become softer, as the experiments show. E. M.

1272. *Activity of freshly-formed Radium Emanation.* **H. H. Poole.** (Phil. Mag. 27. pp. 714–718, April, 1914.)—As there is no very satisfactory explanation of the exponential law of radio-active decay, it is not unreasonable to suppose that variations from it might occur under certain conditions. For instance, as has been suggested by Joly, it is possible that the rate of decay, and hence the activity of a body, might be anomalous when the body is freshly formed so that its age is only a very small fraction of its average life. Accordingly, the author has compared the activity of RaEm a few seconds old with that of the same emanation at the age of a few minutes. The results were negative, nothing anomalous being detected. E. M.

1273. *Refractive Index of Radium Emanation.* **A. W. Porter and C. Cuthberson.** (Röntgen Soc., Journ. 10. pp. 2–9, Jan., 1914. Presidential address of A. W. Porter.)—The difficulties lay in the small quantity of gas available (1/10 mm.^{3}) and the difficulty of keeping the gas pure. A specially-designed Fabry-Perot interferometer was used. The vessel into which the emanation was introduced had two plane-parallel faces (distance apart, e), partly silvered in the insides. The ordinary Fabry-Perot fringes were obtained with a vacuum between the plates, the emanation was then introduced and the refractivity determined from the number n of bright bands which passed over a fixed point in the observing telescope, *i.e.* $\mu - 1 = n\lambda/2e$. Owing to the difficulty of working with the pure emanation and to the limited supply available, no definite values have so far been obtained, but the results show that the refractivity of the emanation is higher than that of any other known gas and at least 25 times that of helium. From certain theoretical considerations of the ratios between the refractivities of the inert gases the authors conclude that the value ought to be about 40 times that of He. E. M.

1274. *Periods of Transformation of Thorium and Actinium Emanations.* **P. B. Perkins.** (Phil. Mag. 27. pp. 720–731, April, 1914.)—Since the transformation constant of a radio-active substance is determined from the equation $\lambda = \log_e I_0/I/t$, where I_0 is the initial activity, and I the activity after a time t, it is obvious that the relative error in λ is decreased as t is increased, provided I_0/I can be determined with the same degree of accuracy in each case. In practice the difficulty arises when I is a very small fraction of I_0. In the present method this difficulty is overcome by using an adjustable capacity connected to the leaf system of the measuring electroscope. By diminishing the capacity as decay proceeds, readings can be taken more accurately. The final results for the half-value periods of ThEm and ActEm are 54·5 secs. and 3·92 secs. respectively. E. M.

1275. *Lead and the Final Product of Thorium.* **A. Holmes.** (Nature, 93. p. 109, April 2, 1914.)—It has been considered for some time that the final product of the Ur family is "isotopic," or chemically identical with Pb. The constancy of the Pb/Ur ratio in the case of primary rock-forming minerals of the same geological age, and its sympathetic variation in the case of minerals of different ages, go far to establish this important conclusion. The recent discovery that all the final products of radio-active disintegration fall into group IV. B of the periodic classification has naturally led to the further assumption that each one is isotopic with Pb. If this is the case, then the estimates of geological time, hitherto based on the Pb/Ur ratio, stand in need of revision. It is easy to calculate the relative rates at which Ur and Th generate their final products, and, assuming the latter are isotopic, to express a given quantity of Th in terms of Ur, and so to arrive at a "total equivalent quantity of uranium," U_e, which also takes Th into consideration. On this assumption the ratio Pb/U_e ought to be constant for minerals of the same age, and ought to vary in sympathy with the ages if these should differ.

The author has examined a large number of analyses of radio-active minerals from this point of view, and neither of the above criteria is found to hold. Pb is absent in many thorium minerals. To throw more light on the question the author and R. W. Lawson are at present estimating the Th-content of a series of Norwegian minerals of Devonian age which have already been analysed for Pb and Ur. E. M.

HEAT.

1276. *Determination of the Melting or Solidifying Range of Temperatures of Lava.* **K. Fuji** and **T. Mizoguchi.** (Mathematico-Physical Soc., Tōkyō, Proc. 7. pp. 248–250, March, 1914.)—By means of an arrangement which simultaneously records both the temperature and electrical conductivity of lava the authors obtain the range of temperature over which the lava is melting or solidifying on the assumption, borne out by test experiments on molten NaCl, that the electrical conductivity of the molten lava increases proportionately with the decrease of viscosity. A curve in which current, representing conductivity, is plotted against temperature shows a point of inflection at about 1180° C. which, the authors consider, would correspond to the melting-point of a crystalline substance. The values given of the specific resistance at various temperatures are, in the neighbourhood of the melting-point, somewhat less than that of sea-water. The importance of this high conductivity in connection with its influence upon the propagation of Hertzian waves is pointed out. The results of the melting-point determinations are compared with observations made by one of the authors upon a lava stream from a volcano by means of a Holborn-Kurlbaum optical pyrometer. The results show that the optical pyrometer cannot be relied upon for such measurements. F. J. H.

1277. *The Boiling-point of Sulphur on the Thermodynamic Scale.* **M. Eumorfopoulos.** (Roy. Soc., Proc. Ser. A. 90. pp. 189–208, May 1, 1914.) —The author has supplemented his previous determinations [Abstract No. 88 (1909)] by using silica bulbs instead of glass. The results he obtains are: The boiling-point of sulphur on the Centigrade thermodynamic scale is 444·61°, and the melting-point of ice on the absolute Centigrade thermodynamic scale is 273·13°. A. F.

1278. *Specific Heats of Certain Binary Liquid Mixtures.* **A. Campetti.** (N. Cimento, 7. Ser. 6. pp. 97–107, Feb., 1914.)—The specific heats of binary mixtures of alcohol with diphenylamine, nitronaphthalene, α-naphthylamine and salol are greater than the values calculated by means of the law of mixtures [see Schulze, Abstract No. 781 (1912)]. The liquefaction of solid diphenylamine and α-naphthylamine is accompanied by rapid change in the specific heat, but this is not found to be the case with the above mixtures containing these compounds. Where the temperature of a mixture is lower than the melting-point of one of its components, the latter has the specific heat which it would have in the superfused, and not in the solid, state at the same temperature; to some extent, this behaviour is the inverse of that of water which, as water of crystallisation, exhibits approximately the specific heat of ice, and not that of water, at the temperature of observation.

T. H. P.

1279. *Ion Clouds in Moist Expanded Air.* **G. Quincke.** (Deutsch. Phys. Gesell., Verh. 16. 9. pp. 421–423, May 15, 1914.)—A general discussion of the behaviour of swarms of ions in the condensation experiment from which the author concludes as follows:—(1) The droplets do not fall with constant velocity in vertical paths, but are disturbed by air vortices and possibly by illumination. (2) It is not justifiable, from the sinking speed of the cloud, to calculate the size and number of the droplets. E. H. B.

1280. *Matter in the Superfused State and Discontinuity of some of the Physical Properties in the Neighbourhood of the Melting-point.* **R. Nasini** and **U. Bresciani.** (N. Cimento, 6. Ser. 6. pp. 437–448, Dec., 1913.)—The behaviour near their melting-points of various substances which exhibit marked superfusion has been examined, especially as regards the "Moreschini effect," or the diminution occurring in the rate of cooling. The substances investigated were thymol, anethol, acetic, palmitic, formic, lauric and myristic acids, benzene, phenol, salol, apiole, cinnamic alcohol, sodium acetate and thiosulphate, water, and sulphur. All of these show pronounced superfusion, excepting lauric and myristic acids, with which the phenomenon is uncertain and in any case slight, and palmitic acid, which could be kept superfused over a temperature interval of only a degree. With acetic acid, anethol and thymol, either pure or mixed with small proportions of water or benzene, retardation of the fall of temperature at the melting-point is verified, but there is less certainty in the case of palmitic acid. With the remaining compounds, slight irregularities do apparently occur near their melting-points, but more exact experiments are necessary to decide if these variations are accidental or are of the same nature as, although smaller than, those mentioned above. Density determinations show that, with thymol, anethol and acetic acid, the variation of the volume with the temperature on either side of the melting-point is quite regular. With acetic acid and anethol, the specific heat exhibits a maximum at the melting-point and slightly below the melting-point respectively. Calculation of the coefficients of association of acetic acid, anethol and thymol from the surface tension according to Ramsay and Shields' method shows that the temperature interval including the melting-point corresponds with the most simple molecular magnitude.

The Moreschini-effect seems to be due to a tendency to crystallisation which does not materialise owing to the paucity and smallness of the nuclei; the development of heat is apparently due to the formation of these nuclei. T. H. P.

1281. *Lower Limits of Inflammation of Methane with Mixture of Oxygen and Nitrogen.* **A. Parker.** (Chem. Soc., Journ. 105. pp. 1002–1009, April, 1914.)—By lower limit of mixture the author, in accord with Coward, understands the smallest possible quantity of combustible gas in which self-propagation of flame "upwards" will take place indefinitely after the original source of ignition has been removed. In the case of methane this lower limit is almost identical with that of Burgess and Wheeler [see Abstract No. 512 (1912)], the chief features of whose apparatus are retained by the author. The induction-coil spark is produced in a 2·5-litre bulb, between platinum points; the magnet and the electrical conditions are kept constant. The gases (methane from aluminium carbide) are purified. The inflammation curve (lower limit of methane as ordinate, oxygen percentage in air mixtures as abscissa) descends rapidly as the oxygen percentage increases to 20 per cent., and rises again very slowly as this percentage increases further. The minimum lies at 5·77 per cent., the adiabatic lower limit of methane would be about 2 per cent.; the excess of 3·77 per cent. being accounted for by the heat conducted away to the surroundings and by the energy given out as radiant energy. The lower limit is found to be greater with oxygen than with air; this cannot be explained from the absorptive power for radiant heat, which is small and nearly the same for nitrogen as for oxygen. Thus the author differs in some respects from Dixon and Coward, and it is possible that the ignition temperature of a "mixture" of methane and oxygen is different from that of a "jet" of methane in an atmosphere of oxygen. H. B.

1282. *Ignition of some Gaseous Mixtures by the Electric Discharge.* **H. F. Coward, C. Cooper, and J. Jacobs.** (Chem. Soc., Journ. 105. pp. 1069–1098, April, 1914.)—The experiments, made with mixtures of hydrogen and oxygen in all proportions, with electrolytic gas to which N, CO_2, A are added, with mixtures of CO and oxygen, alone and diluted by other gases, and with mixtures of oxygen with cyanogen, methane, ethylene, show the complexity of the phenomenon. The experiments concern the pressure at which ignition becomes impossible, under the conditions of the ignition, when the gas pressure is lowered; his lower limiting pressure depends upon the conditions of the electric discharge. To obtain comparable results the same induction coil giving a 1·5 cm. spark with 4 volts in the primary was generally used. In the H-O mixture, the ignition pressure rapidly fell off as the oxygen percentage increased; for the proportion 60 to 85 per cent. of oxygen the ignition pressure became almost constant. But electrolytic gas at 80 mm. pressure could be inflamed after the addition of 28 mm. of electrolytic gas itself, of from 8 mm. to 720 mm. of oxygen, and of from 90 to 210 mm. of hydrogen. Further, electrolytic gas which was no longer inflammable became so after certain additions of N, CO_2, A. There is apparently in general no correspondence between ignition pressure and ignition temperature; the thermal conductivity of the mixture becomes significant when the pre-flame period is sufficiently long; an increase in the hydrogen percentage shortens this period; the influence of the specific heat is not considerable, except in the case of CO_2; the heat of reaction and the flame temperature are of little influence in the initiation of a flame in the explosive mixture. The energy of the electric discharge is a very important factor, but very little information is available. The effect of the spark is perhaps (Kaufmann) more mechanical than thermal. The general conclusion drawn is that the ignition of a mixture (the composition of which does not approach too near the dilution limit of inflammability) is determined chiefly by two factors: the thermal conductivity and the energy degraded when the discharge is passed; a third factor may be the activation (atomisation) of the oxygen, but this assumption rests chiefly on the experiments with carbon monoxide. The experiments do not show whether ignition is ultimately a thermal or an electrotonic effect, or, if electrotonic, the ignition is the result of the high degree of compression in the path of the discharge, due to the mutual repulsion of the electrons. The cooling influence of a diluent becomes marked only when the composition of the mixture approaches the dilution limit of inflammability, and a true flame once initiated in a homogeneous mixture will be propagated except in very narrow vessels. An appendix deals with the calculation of flame temperatures based upon Bjerrum's data for specific heats and dissociations. H. B.

1283. *Vapour Pressure of Nitrogen Peroxide.* **A. C. G. Egerton.** (Chem. Soc., Journ. 105. pp. 647–657, March, 1914.)—The vapour pressures of solid nitrogen peroxide have been measured at temperatures ranging from −55°

to —100°, the method employed consisting in the saturation of a known volume of hydrogen passed over the peroxide and estimation of the amount of the latter carried over. With fall of temperature the vapour pressure decreases somewhat more rapidly than would be expected, and the results obtained lie on the curve, $\log p = 1\overline{4}\cdot9166 + 0\cdot604\theta$. Comparison of these results with those obtained above —85° by previous investigators shows that the slopes of the curves differ, although the individual measurements at about —80° are in agreement. The vapour pressures between —60° and —40° have been measured statically and are in accord with those found by the dynamic method. Further, the results agree with those calculated, according to Ramsay and Young's law, from measurements of the vapour pressure of water. The values obtained are in agreement with those of Scheffer and Treub for the solid [see Abstract No. 518 (1912)], if their two lowest values, which do not obey the Ramsay and Young equation, are considered slightly too high. With the aid of Nernst's vapour-pressure equation, approximate values are derived for the chemical constant, the latent heat of vaporisation, the molecular heat, etc., of nitrogen peroxide, but further data are required before accurate numbers can be obtained. T. H. P.

1284. *New Relation between the Critical Quantities: Unity of all Substances in their Thermal Behaviour.* **J. J. van Laar.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 808–822, March 26, 1914.)—The author discusses the deviations from van der Waals' ideal equation of state and suggests that these are caused by the variability of b with the volume and temperature. On the assumption that $b = f(v)$, it is shown that (1) $v_k - b_k = 2b_0$, where v_k is the critical volume and b_k and b_0 the values of b in the critical state and at absolute zero respectively; (2) $b_k/b_0 = 2\gamma$, where γ is the straight diameter expressed by $[\frac{1}{2}(d_1 + d_2) - 1]/(1 - m)$, d_1 and d_2 being the reduced densities of liquid and vapour and m the ratio of the absolute temperatures T/T_k. The values of γ are 0·9 for an ordinary substance, 0·75 for argon, and 0·5 for an ideal substance. Further, assuming that b is independent of the temperature and putting $f' = (Tdp/pdT)_k$, $s = RT_k : p_k v_k$, and $s' = v_k : v_0$, it is found that $2f' = ss'$. Some of the values of these different magnitudes are as follows:—

	s.	s'.	f'.
Ordinary substance	8·77	8·8	7·16
Argon	8·424	8·5	5·99
Ideal substance..................	2·667	8	4

The difference between s and s' is small but never negligible, and their empirical equalisation would lead only to approximate relationships, such as that of van der Waals. The above empirical relations, however, are perfectly exact and seem to hold accurately for all compounds.

Other simple relations derived are: (1) $f' = 8\gamma$, the critical coefficient of pressure being always eight times the reduced coefficient of direction of the straight diameter; (2) $b'_k = (b_k - b_0)^2/b_k v_k$ and (8) $-\beta''K = (b_k - b_0)/b_k$.

A table is given showing the values of the above magnitudes for limiting substances of high molecular weight, ordinary substances, oxygen, argon, hydrogen or helium, and an ideal substance. T. H. P.

1285. *Tables of Thermodynamic Formulæ.* **P. W. Bridgman.** (Phys. Rev. 8. Ser. 2. pp. 273–281, April, 1914.)—The fundamental quantities, the relations of which are here tabulated, are ten in number: p, the pressure per unit area; τ, the absolute temperature; v, the volume of unit mass of the substance; Q, the heat absorbed; $S = \int dQ/\tau$, the entropy; W, the work done by the substance; E, its internal energy; $H = E + pv$, the total heat; $Z = H - \tau s$, Gibbs' thermodynamic potential; and $\Psi = E - \tau s$, the "free energy" of Helmholtz. The specific heats are not included, being first derivatives, $C_p = (\partial Q/\partial \tau)_p$, and $C_v = (\partial Q/\partial \tau)_v$, in the usual notation. Every such derivative has a definite meaning, involves three different variables, and the number of them is 720, connected by various relations, of which the general form is an equation between four of them and certain of the ten fundamentals. The number of such relations is, therefore, 11104865420, and any one can be easily found from tabulation of the 720 in terms of three selected derivatives. Those selected are the three given most directly by experiment: C_p; $(\partial v/\partial p)_\tau$, the isothermal compressibility; and $(\partial v/\partial \tau)_p$, the isopiestic dilatation, the two latter being obtained from the characteristic equation, and C_p by additional calorimetric measurements. The 720 derivatives fall into ten groups, according to the variable remaining constant. Now each is of type $(\partial x/\partial y)_p$, where p fixes the group, and xy are any two of the other nine fundamentals. Write $(\partial x/\partial y)_p \equiv \partial x_p/\partial y_p$; then ∂x_p and ∂y_p may be tabulated separately as appropriate functions of the three selected derivatives, and the value for any desired derivative obtained by substitution for ∂x_p and ∂y_p, and taking the ratio. For if a be any variable which remains the same for the 72, $(\partial x/\partial y)_p \equiv (\partial x/\partial a)_p/(\partial y/\partial a)_p$. This reduces the number of expressions to be tabulated from 720 to 90, and this may be further reduced to 45 by imposing upon the auxiliary function a, as yet unrestricted, the restriction, $(\partial x)_p = -(\partial p)_v$. The a's, so restricted, are not completely determined, but the derivatives are determined except that the entire collection of functions replacing the partial differentials may be modified by the addition of any factor, and this so chosen as to make the functions as simple as possible. The complete tabulation here indicated, with examples of its use, and auxiliary formulæ for simplifying the computation of any second derivative in terms of the four following second derivatives: $(\partial^2 v/\partial p^2)_\tau$, $\partial^2 v/\partial p \partial \tau$, $(\partial^2 v/\partial \tau^2)_p$, and $(\partial C_p/\partial \tau)_p$, are given in the paper. G. W. de T.

1286. *New Formula for the Latent Heat of Vapours.* **M. P. Applebey** and **D. L. Chapman.** (Chem. Soc., Journ. 105. pp. 784–744, March, 1914.)—From the general thermodynamic equation combined with the equation of van der Waals, but assuming that the value of b in the latter is variable with temperature, the authors have obtained formulæ which enable the latent heat of vaporisation to be calculated from the volume relations of the substance in the liquid and gaseous states. The latent heats of non-associated substances calculated have been found to agree satisfactorily with the values of Young. The values of the van der Waals' constant b, and its variation with temperature, have been found for twenty-six normal substances, and for non-associated substances it is shown that the expression $1/v \,.\, db/dt$ is approximately constant (v_0 being the extrapolated molecular volume of the liquid at the absolute zero of temperature). The halogen derivatives of benzene show anomalies which can be explained by the assumption that they are associated to a certain extent. A. F.

1287. *Black-body Radiation.* **G. W. Walker.** (Roy. Soc., Proc. Ser. A. 90. pp. 46–49, April 1, 1914.)—The author submits his empirical radiation function formula [Abstract No. 705 (1912)] to Fourier analysis, showing that the primary type of disturbance required to produce this energy distribution is a solution of the equation $\ddot{x} + 2n_0\dot{x} + n_0^2 x = 0$, where n_0 is a quantity proportional to the temperature θ, and this expresses the motion of an aperiodic dynamical system. If the constants in the formulæ of the author and of Planck are chosen so that they give the same value for Wien's constant $a = \lambda_m \theta$, and so that they agree at the maximum, they agree fairly well, as shown by the accompanying table.

λ/λ_m.	Planck.	Walker.
0·0	0·0	0·0
0·25	0·0004	0·0490
0·333	0·0117	0·1292
0·5	0·2217	0·4096
0·666	0·6802	0·7260
1·0	1·0	1·0
2·0	0·4054	0·4096
3·0	0·1384	0·1292
4·0	0·0564	0·0490
10·0	0·0022	0·0015
∞	0·0	0·0

Lummer and Pringsheim's observations [Abstract No. 370 (1901)] give results lying between the two theoretical curves, and slightly favouring the author's. Paschen's observations [Abstract No. 1049 (1901)] show good agreement with Planck's formula for any one wave-length at different temperatures; but he explains that in order to fit over his range from about μ to 9 μ it must be assumed that, "for some unknown cause, the spectrum is weakened as wave-length increases, and that the observed values must be multiplied by increasing factors, the factor at 9 μ being 1·3 as compared with 1 at μ. According to the author the facts suggest that his formula would make these factors unnecessary. G. W. de T.

1288. *Cyclic Processes between Infinite Neighbouring Isotherms.* **K. v. Wesendonk.** (Deutsch. Phys. Gesell., Verh. 16. 6. pp. 275–280, March 30, 1914.)—Mathematical.

1289. *Wien's Law.* **R. Hargreaves.** (Phil. Mag. 27. pp. 616–617, April, 1914.)—The proofs given usually lack generality as regards shape of enclosure or type of motion. The author deals with the mean effect for an enclosure of any shape, in which each surface element has an arbitrary normal component of small motion. In every small part of the volume, change of wave-length affects the radiation proportionally to *dt*. He then calculates, on the assumption of uniformity of energy content throughout the volume in respect to all wave-lengths :—$\Delta\lambda/\lambda = \Delta v/3v$; and $p\Delta v = \mathrm{E}\Delta v/3v$. These give $(d\mathrm{E} + p\,dv)\mathrm{T} = d(\mathrm{E}\lambda)/\lambda\mathrm{T} = d\mathrm{S}$ say, and if this be a perfect differential $\mathrm{E}\lambda$ and S are functions of $\lambda\mathrm{T}$, so that $\lambda\mathrm{T} =$ constant is the adiabatic relation. G. W. de T.

1290. *Rigorous Deduction of a Fundamental Relation in the Theory of Radiant Heat.* **T. Levi-Civita.** (Accad. Lincei, Atti, 23. pp. 12–21, Jan. 21, 1914.)—Mathematical.

1291. *Radiation Formulæ.* **M. Wolfke.** (Phys. Zeitschr. 15. pp. 463–464, May 1, 1914.)—A discussion in reply to the remarks by G. Krutkow [see Abstracts Nos. 445 and 909 (1914)]. E. H. B.

SOUND.

1292. *Sound Diffraction.* **G. W. Stewart** and **H. Stiles.** (Phys. Rev. 3. Ser. 2. pp. 256–263, April, 1914.)—Describes experiments on this subject dealing with (1) the sound shadow of a sphere and the passage of sound through (2) narrow slits and (3) circular apertures. In the first case the agreement with theory was very good, and thus confirms the theory, and at the same time increases confidence in the Rayleigh disc, which was used in the experiments. In the second and third cases the results were not so concordant, and show the difficulty of securing satisfactory experimental conditions. [See Abstracts Nos. 885 (1912) and 1310 (1913).] E. H. B.

1293. *Quincke's Interference Experiment.* **H. Riegger** and **J. Zenneck.** (Zeitschr. f. physikal. u. chem. Unterricht. 26. 3. pp. 165–166, May, 1913.)—In this classic experiment with Quincke's tube it is recommended that the longitudinal vibrations of a rod clamped in the middle be used as the source of sound, and that a sensitive gas flame be used as the detector. The jet should be conical (of length nearly equal to the diameter), and the opening elliptical (say 1·5 mm. by 0·8 mm.), the gas pressure being about 62 mm. of water column. When indicating, this flame rises in a single, tall column, when not so disturbed it sinks to a low, two-pointed form. E. H. B.

1294. *Influence of X-rays, etc., upon the Velocity of Sound in Gases.* **W. Küpper.** (Ann. d. Physik, 43. 6. pp. 905–928, March 20, 1914. Extract from Dissertation, Marburg, 1912.)—An experimental research whose chief results may be summarised as follows :—The effect of X-rays upon air, oxygen, and nitrogen was shown to be a distinct increase of the velocity of sound, corresponding to a rise of 10% in the ratio of the specific heats. For hydrogen this value was exceeded. The ultra-violet rays of the mercury lamp, when used with oxygen, formed ozone, and thus gave a smaller sound velocity. The effects of radium and of an alternating field were within the experimental errors if existent. E. H. B.

1295. *Quarry Explosion at Wiener-Neustadt.* **J. N. Dörr.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 1683–1732, Oct., 1913.)—Deals with the distant effects of an explosion of about 150 tons of gunpowder in 1912. It was specially noticeable that between the inner and outer regions of audibility there extended a girdle or zone of silence whose width was from 100 to 130 km. E. H. B.

1296. *Phonograph with Motor-drive and Repeat Action.* **R. Pöch.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 1259–1265, June, 1913.)—Describes, by aid of two perspective views, the details of a modified type of the Archive Phonograph driven by a motor but with a mechanism easily permitting the repetition of any word or phrase so often required when the instrument is being used for serious study. [See Abstract No. 203 (1913).] E. H. B.

1297. *Vibratory Motions under Incident Sound Waves.* I. **E. Waetzmann.** (Deutsch. Phys. Gesell., Verh. 16. 9. pp. 424–430, May 15, 1914.)—Discusses the vibrations evoked from an asymmetrical elastic system by the incidence of sound waves of one or two frequencies. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1298. *Electronic Charge by Thermodynamical Method.* **F. Wächter.** (Ann. d. Physik, 44. 1. pp. 127–144, April 28, 1914.)—Indicates a method of approximating to the value of the electronic charge by mechanical and thermal considerations. E. H. B.

1299. *Diffusion of Electrons through a Slit.* **J. H. Mackie.** (Roy. Soc., Proc. Ser. A. 90. pp. 69–72, April 1, 1914.)—J. S. Townsend and H. T. Tizard showed how, by measuring the lateral diffusion of a stream of electrons in an electric field, it is possible to find the factor by which the energy of agitation of the electrons exceeds that of the surrounding molecules. In this work a small term was neglected, and the simplified form of the differential equation then solved. The present author examines the error introduced by this lack of rigour, and finds it to vary from 1 in 6000 to 1 in 25. [See Abstract No. 1462 (1913).] E. H. B.

1300. *Electric Charges less than that on the Electron.* **F. Ehrenhaft.** (Comptes Rendus, 158. pp. 1071–1073, April 14, 1914.)—By experiments on a precious metal in the colloidal state and the theory of the Brownian movements, the author calculates that charges exist less than those on the electron. The values of the charges found expressed in electrostatic units range as follows: $8{\cdot}5, \ldots 0{\cdot}88, 0{\cdot}69, 0{\cdot}61, 0{\cdot}14 \times 10^{-10}$. [See Abstracts Nos. 282, 503, 947 (1911), and 509 (1914).] E. H. B.

1301. *Determination of e/m for Canal Rays in Hydrogen.* **W. Hammer.** (Ann. d. Physik, 43. 5. pp. 653–686, March 13, 1914.)—The paper contains a fuller account of the experiments described in Abstract No. 370 (1912). Canal rays produced in hydrogen are allowed to pass into a vessel at a pressure of less than 10^{-6} mm. Hg as in the experiments of J. J. Thomson. The rays are first deflected by combined electric and magnetic fields so that parabolic patches of light are produced on a willemite screen placed in their path. By means of a universal spherical glass joint a small hole in the screen is adjusted to be on the parabola corresponding to H_+. In this way a pencil of rays of definite velocity is obtained, even though the potential in the discharge tube might vary during the experiment. The velocity of the rays so obtained is measured by Des Coudres' method, which consists of the application of two electric fields at right angles to and distant from one another. These electric fields are connected to the same source of alternating e.m.f. so that the light produced by the rays on a screen placed beyond the electric fields assumes the form of an ellipse unless the time taken for the rays to travel the distance between the fields is equal to some simple multiple of the half-period of the alternating source, in which case the ellipse becomes a straight diagonal line. In the experiments rays were used with $v = 2{\cdot}52 \times 10^8$ cm./sec., the pencil being homogeneous to $\frac{1}{2}$ %. The value found for *e/m* was 9755 which agrees, within the experimental error, with the value 9654 for the hydrogen ion in electrolysis. E. M.

1302. *The After-effect in Dielectrics.* **K. W. Wagner.** (Archiv f. Elektrotechnik, 2. pp. 371–387, 1914. Communication from the Physikal.-Techn. Reichsanstalt.)—A mathematical paper in which the author shows that the behaviour of an actual dielectric can be imitated by a model consisting of a matrix of perfect non-conducting dielectric with globules of imperfect conducting material embedded in it. F. T. C.

1303. *Measurement of Atmospheric Conductivity.* **W. F. G. Swann.** (Terrestrial Magnetism, 19. pp. 23–37, March, 1914.)—The best known method of measuring the conductivity of air is that devised by Gerdien, in which air is drawn through a cylindrical condenser, and the rate of movement of the leaf of an electroscope connected to the inner cylinder noted. Another method has, however, been developed at Potsdam, in which the conductivity is deduced by noting the rate of alteration of potential of a long, charged wire, surrounded by an earthed netting. This latter apparatus is readily applicable to automatic registration, but as the values of the conductivity as measured by this method at Potsdam are abnormally low the author has investigated the theory of its action. The netting is earth-connected in practice, and as it is situated some distance above the ground it has to take up a negative charge in order to maintain its potential zero. This charge will tend to spread out the negative ions as they are brought to the net by the breeze, with the result that too small a value of the conductivity will be obtained. The greater the air velocity, the less the error. Moreover, under very frequently occurring conditions, this form of apparatus is likely to give a value of the conductivity only about 60 % of the true value. With regard to positive ions, by the very same action that the net concentrates them into a denser steam, it attracts them to itself, and so prevents them entering the interior of the net. The action of the atmospheric potential gradient in causing a charge to appear on pieces of earth-connected apparatus is one which may make itself felt in many experiments. For instance, the ordinary Gerdien apparatus, when mounted on a pedestal some distance above the ground, must have a negative charge on the outer cylinder, and this charge will tend to widen out the stream of negative ions entering the cylinder and attract the positive ions to itself. Again the consideration is of importance in the action of a charged wire in collecting active deposit from the atmosphere. E. M.

DISCHARGE AND OSCILLATIONS.

1304. *Origin of Thermal Ionisation from Carbon.* **O. W. Richardson.** (Roy. Soc. Proc., Ser. A. 90. pp. 174–179, May 1, 1914.)—The paper is a criticism of the experiments of J. N. Pring on this subject and the conclusions he draws from them [see Abstract No. 528 (1914)]. The smallness of the thermionic currents observed at temperatures in the neighbourhood of 1800° C. and at very low pressures is due to the magnetic effect of the large current of 80 amps. employed to heat the carbon, it being shown that on account of the magnetic deflection none of the electrons emitted by the carbon would reach the collecting electrode. This effect may not be present at lower temperatures, but the minimum currents observed at these temperatures cannot from existing data be said to be smaller than those which would be called for by the ordinary thermionic theory. An increase of current with increasing gas pressure as found by Pring would be expected on account of both the interference of the gas molecules with the motion of the electrons and the combination of the electrons with atoms and molecules of the gas; these would diminish the effect of the magnetic field. The large specific effects produced by traces of different gases seem to indicate that the combination of the electrons with atoms or molecules is an important factor; this is borne out by the fact that the order of the effects with different gases is very much the same as that found by J. J. Thomson for the relative frequency of occurrence of the corresponding negatively-charged atoms and molecules in positive rays. Even if the electronic emission were due to chemical action some such effect as the above would be necessary for the existence of any current at all at the high temperatures. If, however, chemical action were the determining factor, it would be expected that the effect with CO_2 would be of quite a different order from that with the other gases investigated. The experiments cannot therefore be held either to prove that the emission of electrons from hot carbon is an immediate consequence of chemical action between the carbon and the surrounding gases, or to invalidate those theories which regard this effect as a physical property of the hot solid. F. J. H.

1305. *Photoelectric and Photo-chemical Action.* **O. W. Richardson.** (Phil. Mag. 27. pp. 476–488, March, 1914. Paper read before the Amer. Physical Soc., Chicago, Nov., 1913.)—The experimental complexity of relations between number of emitted electrons and stimulating radiation makes advisable a wide basis for a theory of these actions, and an attempt is here made to develop such a theory on the basis of the energy abstracted from radiation in liberation of an electron or atom, and since argument is unaffected by existence of change the term "atom" may be taken to include ions and electrons. The fundamental equation obtained involves the assumption, as yet not tested experimentally, that the number of atoms emitted by a given amount of light is the same whether light is or is not decomposed, without energy loss, into its spectral constituents, which is the simplest assumption consistent with photoelectric evidence that the number of emitted electrons is simply proportional to the intensity of light of definite spectral composition, but varies greatly for equal energies and for different frequencies. It is also assumed that: the distribution of energy in the radiation is given by Planck's formula; that photo-chemical actions are fundamentally independent of temperature at low temperatures, as is indicated by the experimental evidence, and that they do not contravene the second law of thermodynamics; that the contribution of the radiation to the mean internal energy of the emitted atoms, *i.e.* their kinetic energy in the condensed form, is negligible. This last assumption is a very real restriction of the theory, which it makes essentially a provisional one, since the whole of the internal energy of the atoms might quite possibly arise from the radiation. The fundamental equation is then shown to lead to the conclusion that $\phi(\gamma) = h\gamma$, where h is Planck's constant, and $\phi(\gamma)$ is the mean energy which each atom, liberated under the influence of monochromatic radiation of frequency γ, has acquired from the radiation at the moment of liberation. It is then further shown that a consistent scheme of relations may be framed whereby this equation may hold good at all temperatures. In comparing the scheme so formulated with experiment it must be remembered that the neglect of the part played by electron reflection in the electrical case, and by corresponding atomic deflections in other types of photo-chemical action, although not affecting the equilibrium values, will affect photoelectric results dealing, not with a state of equilibrium, but with the rate of emission under a given illumination. G. W. DE T.

1306. *Influence of Occluded Gases on the Selective Photoelectric Effect.* **R. Pohl** and **P. Pringsheim.** (Deutsch. Phys. Gesell., Verh. 16. 7. pp. 336–344, April 15, 1914.)—Potassium which had been boiled continuously for in one case 180 hours and in another 480 hours in an extremely good vacuum, whereby its yield of occluded hydrogen changed from 2 c.cm. to 4×10^{-4} c.cm. per hour per c.cm. of potassium, was found to give the same selective photoelectric effect to within the limits of experimental error as potassium not so treated. The presence of hydrogen in the metal does not therefore appear to be of prime importance. This result is in direct opposition to that obtained by Wiedemann and Hallwachs [see Abstract No. 722 (1914)], the cause of which the authors are unable to explain. A general discussion on the causes of the emission of electrons by short electromagnetic waves, by chemical action, and by heat and the possibility of connecting them is included. F. J. H.

1307. *Transmission of Kathode Rays through Matter.* **R. Whiddington.** (Roy. Soc., Proc. Ser. A. 89. pp. 554–560, March 2, 1914.)—Homogeneous kathode rays of known speed were allowed to fall on sheets of metal of various thicknesses and the fraction transmitted was determined. The results show that the law of Lenard stating that the absorption coefficient is connected with the speed by the relation $\lambda v^4 = \text{constant}$, is not generally true when λ is determined by the number of rays incident and transmitted. The alternative formula $\lambda = b/v^4 + c$ is shown to represent the facts more closely within certain limits of velocity. It appears that the lower limit of velocity, to which the formula is applicable, depends only on the thickness of the absorbing sheet. This provides a ready method of determining the constant a in the relation $v_0^4 - v_x^4 = ax$, which gives the variation in speed of the rays traversing the absorbing sheet [see Abstract 818 (1914)]. The results show that a/ρ^4 is constant, where ρ is the density of the absorber. Except in the case of copper no definite effect of selective absorption could be observed when the speed of the kathode rays is just sufficient to excite the characteristic radiation of the material they traverse. E. M.

1308. *Phenomena in Rarefied Gases.* **B. Baule.** (Ann. d. Physik, 44. 1. pp. 145–176, April 28, 1914.)—The paper deals theoretically with (*a*) the abrupt change of temperature which exists at the surfaces of solids placed in a rarefied gas to establish a temperature gradient, (*b*) the analogous phenomenon of "surface slip" occurring in experiments on the viscosity of rarefied gases, (*c*) the thermal conductivity of strongly rarefied gases, and (*d*) the viscosity of the same. Treating the solid body placed in the gas as a cubical space lattice in which the molecules or atoms vibrate about the lattice points with a mean kinetic energy proportional to the absolute temperature of the body, the author first deduces expressions for the above quantities in terms of well-known constants for the gas and the distance apart of the molecules of the solid. The abrupt temperature change is found to be proportional to the temperature gradient in the gas and the surface slip proportional to the velocity gradient, both being inversely proportional to the pressure as is borne out by experiment. The calculated values are in excellent agreement with the experimental results of P. Lasareff [Abstract No. 882 (1912)] for the former and of A. Timiriazeff [Abstract No. 1246 (1913)] for the latter. The expressions previously arrived at by Smoluchowski for the abrupt temperature change and the surface slip are similar to those now obtained but involve unknown constants; in the author's treatment these constants are connected with other well-known constants for the gas. Moreover, the simple connection which, according to Smoluchowski, exists between the constants for the two phenomena and which was found by Timiriazeff to break down completely in the case of hydrogen, is shown to be erroneous. In obtaining expressions for the thermal conductivity and the viscosity of highly rarefied gases the rarefaction is considered to be so great that the effects of the collisions of the molecules of the gas with one another are negligible in comparison with their collisions with the molecules of the solids in them. The values obtained for the thermal conductivities of H, O, and CO_2 are in good agreement with the values obtained experimentally by Knudsen [Abstract No. 899 (1911)]. F. J. H.

1309. *Alternate-current Discharge with Small Current between Metal Electrodes.* **E. Merkel.** (Ann. d. Physik, 43. 5. pp. 725–748, March 18, 1914. Extract from Dissertation, Göttingen, 1913.)—Guye and Monasch in measuring the p.d. across an alternating-current arc between metal electrodes, found that below a certain arc length the effective p.d. instead of falling began to increase and to show marked irregularities. The anomaly showed itself with all pure metals and with an arc length of from 0 to 8 mm. [see Abstract No. 917B (1904)]. The author finds that these irregularities are due to irregularities in the p.d. (*a*) required to start the arc and not to irregularities in the lower p.d., (*b*) which maintains the current during the remainder of the half-period of alternation. The irregularities may be removed by allowing ultra-violet light to fall on one electrode, but the p.d. (*a*) still shows an anomalous behaviour below a certain arc length. As the arc is reduced in length below 8 mm., the p.d. (*a*) rises instead of falling, until the arc length has been reduced to about 2 mm., when it falls again. The p.d. (*b*) is throughout proportional to the length of arc. The irregularity in (*a*) extends for a greater arc length in H than in air or CO_2. Diminishing the pressure also increases the range of the irregularity. (*a*) is, in general, higher in air than in H or CO_2. (*b*) is, in general, higher in H than in air or CO_2. (*a*) is affected by the material of the electrodes only in CO_2, whereas (*b*) is dependent to a considerable extent on the material of the electrodes. The form of the p.d. curve is obtained by an oscillograph.

T. P. B.

1310. *Striations in Pure Gases, and the Influence of Impurities.* **P. Neubert.** (Phys. Zeitschr. 15. pp. 480–483, May 1, 1914.)—The author has shown [Abstract No. 941 (1914)] that the striations in a discharge in hydrogen are modified considerably by the addition of traces of oxygen, which widens the limits of pressure within which striations are possible. He now shows that another electro-negative gas, namely iodine vapour, modifies the striations in hydrogen to a greater extent, and suggests that the greater the differences between the electrical properties of the gases, the more pronounced is the modification of the striations. He gives further illustrations of this view. Gehlhoff's discovery [Abstract No. 488 (1913)] that in very pure nitrogen and helium no striations are possible has been shown to apply also to pure oxygen, and to mercury-vapour. Even with slight traces of impurities, the unstriated discharge is still obtained. It was not possible to get an unstriated discharge in hydrogen, but this may be due to the difficulty of getting very pure hydrogen. With pure oxygen it was found that not only do the striations vanish, but for certain conditions [high p.d. between the electrodes, 2 mm. Hg pressure and current densities of about 10 milliamps.] the discharge was absolutely dark. Adding hydrogen under these conditions gives the red discharge of hydrogen which shows only the hydrogen spectrum. J. R.

1311. *Oscillating Spark as an Economic Source of Ultra-violet Light.* **J. de Kowalski.** (Comptes Rendus, 158. pp. 1387–1389, May 11, 1914. Soc. Int. Élect., Bull. 4. Ser. 3. pp. 437–450, May, 1914.)—Experiments have been made with a view to obtaining the most suitable conditions for the production of ultra-violet light from the spark of an oscillatory circuit, and, in particular, of the "mean ultra-violet rays" used in sterilisation and photochemical reactions. It is found that the region of max. radiated energy is displaced towards the longer wave-lengths as the current in the oscillatory circuit is increased but towards the shorter wave-lengths the greater the amount of energy consumed in the spark; its position and intensity varies also with the nature of the electrodes. The intensity of the "mean ultra-violet rays" increases as the frequency of the oscillations decreases. If a resonance transformer is used as the source of the oscillations a definite relation can be obtained between the number of sparks per sec., the capacity, and the frequency of the primary current, and thus the most economic conditions of working can be obtained. F. J. H.

1312. *Continued Appearance of Gases in Vacuum Tubes.* **G. Winchester.** (Phys. Rev. 3. Ser. 2. pp. 287–294, April, 1914.)—The following facts are noticed in connection with the liberation of gases from chemically pure Al electrodes in discharge tubes by the application of large potentials from an induction coil:—(1) There is no relation between the amounts of gases thrown off and the size of the kathode. (2) The presence of hydrocarbons has no influence upon the amounts or kinds of gases evolved. (3) Hydrogen is evolved as long as any of the kathode remains. (4) Helium and neon are eliminated after a comparatively short time. Experimental curves in which pressure is plotted against time are given. These show that for the first few hours gas is evolved at a greater rate than subsequently, the rate of evolution finally assuming a steady value so long as the conditions remain steady. If the tube is rested or if the potential is increased or if the gas is quickly pumped out the rate of evolution increases for an hour or two, but finally assumes a steady value again. The author concludes that helium and neon are most probably occluded in the surface only, having been previously absorbed from the atmosphere. Hydrogen may possibly be a disintegration product of the metal in somewhat the same manner as the α-particle is disintegrated from radium, the hydrogen requiring the assistance of the large electric force to enable it to leave the metal. F. J. H.

1313. *Diffraction of Electric Waves Round a perfectly Reflecting Sphere.* **H. M. Macdonald.** (Roy. Soc., Proc. Ser. A, 90. pp. 50–61, April 1, 1914.) —In a previous paper [Abstract No. 609 (1910)] the author calculated the effect produced at a point P on a perfectly conducting sphere by a Hertzian oscillator placed outside the sphere, when the radius is large compared with the wave-lengths considered. The calculation failed for the case of the oscillator on the surface. A series is here obtained which converges rapidly for large values of θ, the angular distance of the point P, at a distance r from the centre of the sphere of radius a ($r > a$) from the oscillator. The accompanying table, in which λ is the earth's surface wave-length, and the second column gives the distance in miles of P from the oscillator, and $r = a$, shows the nature of the results obtained. The first term of the series only has been taken, the effect of the second and following terms being negligible except for the first three entries in the last column and the first entry in the preceding column, where the second place of decimals may possibly be affected. They confirm the remark in a recent paper by Rybczynski [Abstract No. 1489 (1913)] on the impossibility of representing the facts by a single exponential as the oscillator is approached.

θ.	Miles.	λ = 320 metres.	*λ = 625 metres.	λ = 1280 metres.	λ = 2560 metres.	λ = 5000 metres.
° ″						
6 0	419	0·18	0·34	0·54	0·80	1·04
6 20	442	0·15	0·30	0·49	0·74	0·98
6 40	465	0·13	0·26	0·44	0·69	0·93
7 0	489	0·11	0·22	0·40	0·64	0·88
7 20	512	0·09	0·19	0·36	0·59	0·83
7 40	535	0·07	0·17	0·32	0·55	0·78
8 0	559		0·15	0·29	0·50	0·73
8 20	582		0·13	0·26	0·46	0·69
8 40	605		0·11	0·23	0·43	0·65
9 0	628		0·09	0·21	0·39	0·61
9 20	652		0·08	0·18	0·36	0·57
9 40	675		0·07	0·16	0·33	0·53
10 0	698			0·14	0·30	0·50
10 20	721			0·13	0·28	0·47
10 40	745			0·11	0·26	0·44
11 0	768			0·10	0·24	0·41
11 20	791			0·09	0·22	0·38
11 40	814			0·08	0·20	0·36
12 0	837				0·18	0·34
12 20	861				0·16	0·32
12 40	884				0·15	0·30
13 0	907				0·14	0·28
13 20	931				0·13	0·26
13 40	954				0·12	0·24
14 0	977				0·11	0·22
14 20	1000				0·10	0·21
14 40	1024				0·09	0·20
15 0	1047				0·08	0·18
15 20	1070				0·08	0·17
15 40	1094					0·16
16 0	1117					0·15
16 20	1140					0·14
16 40	1164					0·13
17 0	1187					0·12
17 20	1210					0·11
17 40	1233					0·10
18 0	1257					0·10

G. W. DE T.

1314. *Induction-coil Potentials.* **E. T. Jones.** (Phil. Mag. 27. pp. 565–586, April, 1914.)—The paper is a continuation of two former ones [see Abstracts Nos. 527 (1909), 578 (1912)]. In one of these the secondary voltage of two coupled oscillation circuits, t secs. after the primary is set oscillating, is given by the expression $A_1e^{-k_1t}\sin(2\pi n_1t-\delta_1) - A_2e^{-k_2t}\sin(2\pi n_2t-\delta_2)$, where n_1, n_2 are the frequencies of the two oscillations of the system and the other six constants can be calculated from the capacities, inductances, and resistances of the circuit. The paper describes tests on the application of the theory to an 18-inch induction coil with three different condensers in the primary circuit. The various constants of the circuit are determined experimentally—where possible, in more than one way—and the calculated voltage is compared with that determined experimentally. An oscillograph is used to determine frequencies and secondary voltage. The experimental and theoretical values agree well and the theory given in the previous papers is thus shown to be sufficient for the calculation of the secondary potential and the most effective value of the primary condenser. The experimental results show that to about 4 % the secondary voltage is proportional to the primary current. No matter how rapid the break of the primary current, a certain amount of capacity across the break increases the length of the secondary spark. The most efficient value of the coupling of the two circuits is 0·756. T. P. B.

1315. *Characteristic Curves and Sensitiveness Tests of Crystals and other Detectors.* **P. R. Coursey.** (Phys. Soc., Proc. 26. pp. 97–114; Discussion, pp. 114–116, Feb., 1914. Electrician, 73. p. 188, May 8, 1914. Abstract.)—The tests described in this paper were taken with a view to finding out whether the second differential of the characteristic curve bears any resemblance to the curve of sensitiveness to wireless signals, as is known to be the case for valve detectors of the Fleming type. A number of curves accompany the paper and these should be referred to. H. H. H.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1316. *Dielectric Constants of Certain Highly-compressed Gases and the Mossotti-Clausius Relation.* **A. Occhialini.** (N. Cimento, 7. Ser. 6. pp. 108–126, Feb., 1914.)—Following on his work on air [Abstracts Nos. 1048, 1486 (1913)] the author has measured over wide intervals of pressure the dielectric constants of pure oxygen, hydrogen, and carbon dioxide. It is found that, under these conditions, the results obtained are not in agreement with the empirical relation, $(K-1)/d =$ constant but accord very exactly with the Mossotti-Clausius formula, $(K-1)/(K+2)d =$ constant, where K represents the dielectric constants and d the density of the gas. [See Abstract No. 588 (1913).] T. H. P.

1317. *Absolute Measure of the Peltier-effect between Metals and Electrolytes.* **G. Guglielmo.** (Accad. Lincei, Atti, 23. pp. 493–499, April 5, 1914.)—The author has measured the Peltier-effect between a metal and an electrolyte by Jahn's method, which consists in measuring the separate amounts of heat evolved when a current is passed from the metal to the electrolyte and from the electrolyte to the metal. The Joule effect being the same in both cases, the difference between the two amounts of heat, when suitably corrected, represents twice the Peltier-effect. Measurements were made with plates of amalgamated zinc in a solution (density, 1·296 at 21·50°) of 148·5 gm. of crystallised zinc sulphate in 178·5 gm. of water. For the amount of heat evolved in the passage of the coulomb from the zinc to the solution, values varying from 35·5 to 60 milligramme-calories were obtained, the mean being 48·9. With a solution of zinc iodide containing 52 gm. of the salt to 202·5 gm. of water, and having the density 1·20 at 20°, the values ranged from 37 to 46·5 milligramme-calories, the mean being 42 milligramme-calories per coulomb. T. H. P.

1318. *Electrical Condition of a Gold Surface during the Absorption of Gases and their Catalytic Combustion.* **H. Hartley.** (Roy. Soc., Proc. Ser. A. 90. pp. 61–68, April 1, 1914.)—A gauze of fine gold wire connected to an electrometer was suspended in a vessel which could be exhausted and heated to about 850° C. The voltage acquired by the gauze was measured, (*a*) while the combination of oxygen and hydrogen went on at its surface [see Abstract No. 1628 (1906)], (*b*) while H, O, or CO were being absorbed by the metal, and (*c*) while CO and O were combining at the surface to form CO_2. The author draws the following conclusions from his observations :—(1) A gold surface acquires a negative charge during the catalytic combustion of gases in contact with it. (2) This electrical effect is probably antecedent to the actual combustion, and is primarily due to occlusion. (3) The metal becomes negatively charged during the occlusion of the combustible gas (H or CO), and positively charged during the occlusion of O. (4) Such electrical effects are probably due to occluded gas which is leaving rather than entering the metal. Any cause, such as a sudden lowering of temperature, which would momentarily check the overflow of occluded gas, will likewise diminish the charge, or may even momentarily stop it altogether. Conversely, a sudden diminution of the gas pressure in the vicinity of the metal, which would increase the rate of outflow of the occluded gas from the metal, will temporarily increase the intensity of the electrical effect. (5) These temporary disturbances are probably due to the fact that a change in either temperature or pressure of the system is accompanied by a change in the dynamic equilibrium between the ingoing and outflowing gas. F. J. H.

1319. *Influence of Temperature on Electro-capillary Phenomena.* **P. Kandidof.** (Russian Physico-Chemical Soc., Journ. 45. [Physical Part] pp. 207–209, 1913.)—Within the limits of temperature, 17° and 65°, the variation of electro-capillarity is found to be less than 1 per cent., and is hence constant within the limits of experimental error. T. H. P.

1320. *Use of Radium for Lightning Conductor.* **B. Szilard.** (Comptes Rendus, 158. pp. 695–697, March 9, 1914.)—A disc coated with about 2 mgm. radium bromide is placed near a pointed rod and it is found that the ionisation produced helps to prevent a disruptive discharge. E. M.

1321. *Note on the use of the Wilson Tilted Electroscope.* **H. W. Farwell.** (Amer. Journ. Sci. 37. pp. 319–320, April, 1914.)—In using the tilted electroscope the author has noticed a lack of steadiness of the zero of the leaf. By placing a glow-lamp in various positions near the instrument he now shows that the fluctuations are due to convection currents within the electroscope case. Hence the necessity for adjusting the suspensions in a fair vacuum. W. C. S. P.

1322. *Contact-electricity between Gases and Conducting and Non-conducting Fluids.* **A. Coehn** and **H. Mozer.** (Ann. d. Physik, 43. 7. pp. 1048–1078, April 2, 1914. From Dissertation, Göttingen, Feb., 1913.)—The object of the research here described was to determine whether the contact of gases with non-conducting liquids follows the law of charging found by Coehn [Abstract No. 145 (1910)] for dielectrics, and also what effect would be produced in the case of electrolytically conducting liquids. A method of investigation was employed of bubbling the gas through the liquid and measuring the resulting charge by means of a sensitive quadrant electrometer. The following are some of the results of the investigation:—(1) In the case of the contact of gases with non-conducting or slightly-conducting liquids the law of charging for dielectrics, that substances of higher dielectric constant become charged positively by contact with substances of lower dielectric constant, was established both for pure liquids and for solutions of non-conductors in water. (2) With solutions of electrolytes in water the negative charge of the gas and the corresponding positive charge of the liquid decrease with increased concentration, and for a certain concentration a reversal point is reached beyond which the gas acquires a positive charge. (3) The reversal point was investigated for a number of electrolytes with various anions and kathions by bubbling through them oxygen and hydrogen. It was found that with acids the reversal point was given by much smaller concentrations than with neutral salts or alkalies. (4) The question whether the null charge at the reversal point corresponds to the existence of no charged carriers, or to the presence of equal numbers of positive and negative carriers was also dealt with. For all liquid non-conductors, including pure liquids as well as solutions of non-conductors in water, only negative carriers can be produced in the gas. In the case of electrolytes the positive carriers increase with increased concentration till at the null point both positive and negative carriers exist in equal numbers. A. W.

1323. *Measurement of Capacity by a Guard-ring Condenser.* **G. Hoffmann.** (Phys. Zeitschr. 15. pp. 360–361, April 1, 1914.)—The author advocates the use of the guard-ring condenser for the measurement of the absolute capacity of an electrometer and its accompanying apparatus. He describes and illustrates the form of condenser used. In the calculation, let the suffix *a* refer to the unguarded plate of the condenser, *i* to that plate which is connected with the electrometer, etc., *o* to all the other conductors present, then the charge on the plate *i* is given by $e_i = C_{ii}V_i + C_{i0}V_0 + C_{ia}V_a$ with the usual notation. C_{ia} is known from the dimensions of the apparatus, V_0 is made zero, e_i is kept constant during an experiment, hence a change in V_a of V'_a produces the effect in *i* of an additional charge $-C_{ia}V'_a$. By altering the potential of the plate *a* the electrometer may thus be calibrated for electric charge. If the electrometer has already been calibrated for potential its "working" capacity may be found from the formula $C_{ii} = -C_{ia}V'_a/V'_i$, where V'_i is the change of reading produced by a change of V'_a in the potential of the plate *a*.
J. W. T. W.

1324. *Determination of Electromotive Force of Weston Normal Cell in Semi-absolute Volts.* **A. N. Shaw** and **H. L. Callendar.** (Roy. Soc., Phil. Trans. 214. pp. 147–198, May 12, 1914.)—This paper presents the result of an absolute determination of current performed with the aid of a modified form of bifilar Weber electrodynamometer. The former obstacles to a precise use of this type of instrument have been overcome and it is claimed that the absolute accuracy of the value of the e.m.f. of the Weston normal cell has been increased by this investigation. The paper deals with the general theory of the instrument and its construction, the calculation of the dynamometer constants and the determination of the e.m.f. of standard cells. The theory and method of measuring the mean radius of the small coils by electromagnetic comparison with the large coils was one of the most difficult parts of the investigation and nearly 400 observations for various quantities are involved in the final mean. It is thought that an accuracy of 1 part in 100,000 is obtained. The standard resistances were compared with the standards in the Bureau of Standards at Washington and the standard cells were compared with cells at Washington in 1908 and 1909, and with those at the National Physical Laboratory in 1909 and 1912. The value given for the e.m.f. of the Weston normal cell is 1·01831 semi-absolute volts at 20° C.

F. E. S.

1325. *Comparison of nearly equal Electrical Resistances.* **G. F. C. Searle.** (Cambridge Phil. Soc., Proc. 17. No. 4. pp. 340–350, Jan. 30, 1914.)—The best known method of determining the ratio of the resistances of two nearly equal coils is that of Carey Foster in which the difference of the resistances is expressed as the resistance of a measured length of graduated wire. In recent years this method has been abandoned for comparisons of the highest precision and a method of shunting is now employed. The great advantage of the method of shunting is that instead of dealing with the resistance of 1 or 2 mm. of the wire of the bridge, we have to deal with shunting resistances measured by many hundreds of thousands of ohms. The general theory of the method is given and this is followed by some practical details of measurements made in the Cavendish Laboratory. The paper should prove useful to teachers.

F. E. S.

1326. *Kathode-ray Oscillograph.* **A. Dufour.** (Comptes Rendus, 158. pp. 1339–1341, May 11, 1914.)—A modification of the ordinary Braun-tube oscillograph is described which is designed for the purpose of recording photographically variable currents which are not periodic. The fluorescent screen is dispensed with, and the bundle of kathode rays allowed to impinge directly on the photographic plate. By the application of an alternating field of frequency 10,000 obtained by means of a singing arc the impression on the plate is drawn out into a straight line. A direct field is now applied at right angles to the first, and its intensity caused to change abruptly, the duration of the change being of the order of a thousandth of a second. In this way a sinusoidal curve is traced which gives a time scale. The phenomenon to be studied is then allowed to act in such a way that the variable deviation is produced in a direction at right angles to the original straight line. A sensitiveness of 1 mm. per one three-millionth of a second is obtained. The author contemplates using this method for studying the form of currents in aerials and detectors of various kinds.

For the production of the kathode rays a large electrostatic machine is found to be the most satisfactory.

F. J. H.

1327. *Vibration Galvanometers of Low Effective Resistance.* **A. Campbell.** (Phys. Soc., Proc. 26. pp. 120–126, Feb., 1914.)—The author gives the mathematical theory of the moving-coil vibration galvanometer, and obtains simple relations between the two resonance frequencies: the free frequency and the amplitude time constants [see Abstract No. 1377 (1913)]. It is also shown how all the constants of the equation of motion can be deduced from observations of the direct- and alternating-current sensitivities, the alternating voltage sensitivity, and the "dead" resistance. Complete results of tests on a number of coils are given, unifilar suspensions of phosphor-bronze strip being used in all cases. The number of turns was varied from 1 to 40. The current sensitivities ranged from 6 mm. to 160 mm. per microamp. at 1 m. and at 100 ∿ per sec., the corresponding effective resistances being about 9 ohms and 1500 ohms respectively. It is seen that it is possible to obtain good current sensitivity with coils having effective resistances as low as 30 or 40 ohms.

It is also pointed out that the selectiveness (for given current) due to resonance is mainly determined by the absolute value of the "amplitude time constant": the more sluggish a galvanometer is in settling to zero the more selective will it be. In the *discussion*, **G. W. O. Howe** pointed out that the method adopted by the author was similar to that of finding the no-load losses and efficiency of a motor by cutting off the supply and observing the rate of slowing down. W. C. S. P.

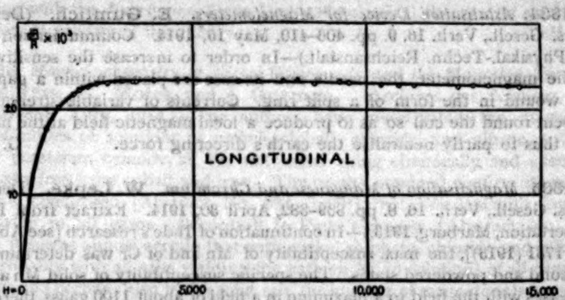
ALTERNATING CURRENTS AND MAGNETISM.

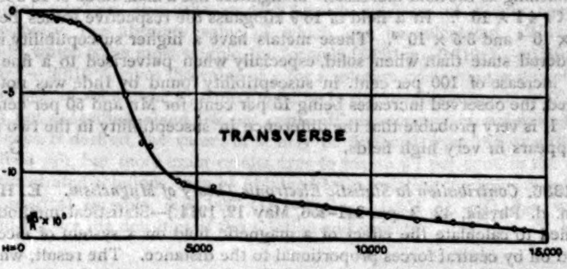
1328. *Effect of Iron upon a Sinusoidal Current.* **E. Marini.** (N. Cimento, 7. Ser. 6. pp. 5–10, Jan., 1914.)—The method of the Braun-tube is used, the circuit containing the iron producing an harmonic displacement of the spot. A circuit in parallel with this, but not containing iron, is arranged to produce an equal and opposite displacement of the spot. Thus the fundamental term is annulled and only the harmonics due to the iron are present, any displacement being due to them. Only one term is of importance, and in the case measured in which this was greatest it amounted to 8·5 per cent. of the amplitude of the fundamental. S. G. S.

1329. *Change in Electrical Resistance of the Heusler Alloys when placed in a Transverse Magnetic Field.* **O. Bonazzi.** (Deutsch. Phys. Gesell., Verh. 16. 7. pp. 815–819, April 15, 1914.)—The author suggests that in order to obtain a simple explanation of the magnetic properties of the Heusler alloys some of the other phenomena exhibited by them should be carefully studied. He investigates the change in resistance of a non-inductive spiral of the alloy, 0·1 mm. diam. when placed in a transverse magnetic field which can be varied up to 30,000 gauss. The resistance of this particular Cu-Mn-Al alloy is found to decrease with increase in the field, and is thus similar to ferromagnetic materials. At the highest field the decrease in the rate of change of resistance shows the approach of a saturation effect. W. C. S. P.

1330. *Iron Shielded from Earth's Magnetism.* **E. Wilson.** (Roy. Soc., Proc. Ser. A. 90. pp. 179–188, May 1, 1914.)—Experiments were made on a ring specimen of stalloy built up from stampings, and a magnetic shield was formed from stampings of transformer iron. The specimen was supported symmetrically within the shield, and the common axis placed at right angles to the magnetic meridian. Measurements taken ballistically with the ring shielded and unshielded show that the earth's magnetism may seriously affect the magnetisability of iron. Comparing the results obtained when stalloy was magnetised and then demagnetised, with the results of similar experiments on the same material demagnetised but exposed to the earth's magnetism, the ratio of the permeabilities had a maximum of 1·79 when B was 172, and the ratio of the maximum permeabilities was 1·24. The maximum μ for the shielded specimen was 5900. The dissipation of energy by hysteresis was less when the stalloy was demagnetised in the shield than when demagnetised and then exposed to the earth's magnetism. The Steinmetz index, after rising to a maximum of about 8 for a force of about 0·008 c.g.s., begins to diminish as the force is reduced, and at about this point the hysteresis loops tend to become parallel straight lines. [See also Abstract No. 1151 (1908).] G. E. A.

1331. *Electrical Resistance of Nickel in Magnetic Fields.* **W. M. Jones** and **J. E. Malam.** (Phil. Mag. 27. pp. 649–659, April, 1914.)—The experiments were undertaken to throw some light on the discrepancy between the results for the longitudinal effect obtained by Owen and Heaps [see Abstracts Nos. 519 (1911) and 574 (1912)]. The slide-wire bridge method was used in conjunction with an instrument by means of which the difficulty of accurately setting the specimen in the field of the electromagnet is obviated. A series of curves, in which *d*R/R is plotted against H for various settings of the specimen at or near the transverse position, indicates that an error of setting of 2½° will give the results of Grunmach and Heaps [see Abstract No. 115 (1907)]. Another series of curves shows the change of the effect with the orientation of the specimen. The two extreme curves for the longitudinal and transverse positions (see Figs.) are given on a larger scale. The change of resistance in the former case attains a maximum in a field of about 8000 c.g.s. G. E. A.





1332. *Change of Length in Nickel in Alternating Fields.* **W. Brown.** (Roy. Dublin Soc., Proc. 14. 21, pp. 297–301, May, 1914.)—From observations of a soft nickel wire, 226 cm. in effective length, subjected to low alternating fields while sustaining a small longitudinal load, it was found that the contraction for the alternating fields was greater than that for the direct fields by about 68 per cent. for the smallest load ($0{\cdot}1184 \times 10^5$ gm.), and by 44 per cent. for the largest load (10^5 gm.). Neglecting values for low fields, the a.c. contraction is nearly in a constant ratio to the d.c. contraction, the ratio varying with the load. G. E. A.

1333. *Measurement of High Inductions by Yoke Method.* **E. Gumlich.** (Deutsch. Phys. Gesell., Verh. 16. 9. pp. 395–405, May 15, 1914. Communication from the Physikal.-Techn. Reichsanstalt.)—Details are given of a simplified apparatus for testing bars or bundles of strips by means of the bar-and-yoke method in fields up to 7500 gauss. An example of a test shows that the results agree well with those given by a modified isthmus method previously described. [See Abstract No. 1756 (1909).] G. E. A.

1334. *Astatisation Device for Magnetometers.* **E. Gumlich.** (Deutsch. Phys. Gesell., Verh. 16. 9. pp. 406–410, May 15, 1914. Communication from the Physikal.-Techn. Reichsanstalt.)—In order to increase the sensitiveness of the magnetometer, the needle and its case are placed within a gap in a coil wound in the form of a split ring. Currents of variable strength can be sent round the coil so as to produce a local magnetic field at the needle, and thus to partly neutralise the earth's directing force. G. E. A.

1335. *Magnetisation of Manganese and Chromium.* **W. Lepke.** (Deutsch. Phys. Gesell., Verh. 16. 8. pp. 369–382, April 30, 1914. Extract from Inaug. Dissertation, Marburg, 1913.)—In continuation of Ihde's research [see Abstract No. 1781 (1913)], the max. susceptibility of Mn and of Cr was determined in the solid and powdered states. The specific susceptibility of solid Mn and Cr increases with the field to a maximum in a field of about 1100 gauss, thereafter diminishing as the field increases. Manganese has a max. value of $10{\cdot}6 \times 10^{-6}$, and Cr $4{\cdot}1 \times 10^{-6}$. In a field of 18·9 kilogauss the respective values become $9{\cdot}4 \times 10^{-6}$ and $8{\cdot}5 \times 10^{-6}$. These metals have a higher susceptibility in the powdered state than when solid, especially when pulverised to a fine dust. The increase of 100 per cent. in susceptibility found by Ihde was not confirmed, the observed increases being 15 per cent. for Mn and 50 per cent. for Cr. It is very probable that the difference in susceptibility in the two states disappears in very high fields. G. E. A.

1336. *Contribution to Statistic Electronic Theory of Magnetism.* **E. Holm.** (Ann. d. Physik, 42. 2. pp. 241–256, May 12, 1914.)—Statistical methods are applied to calculate the effect of a magnetic field on a system of electrons acted on by central forces proportional to the distance. The result, which is opposed to the recent conclusions of Kroo but agrees with the older results obtained by Voigt and J. J. Thomson by non-statistical methods, is that the field causes no magnetisation of electrons. G. E. A.

1337. *Magnetic Susceptibility of Water.* **H. C. Hayes.** (Phys. Rev. 3. Ser. 2. pp. 295–305, April, 1914.)—The methods of measuring the above quantity are classed as those of Faraday, Quincke, and Wills, and the determinations of it from 1855 onwards are tabulated. The chief experimental difficulty in using Faraday's method was overcome by means of a device for placing the specimen at the point for which dH/ds had been accurately determined. The value of the susceptibility of a specimen consisting of 0·150 gm. of distilled water at 24° C. was $-7{\cdot}26 \times 10^{-7}$, which agrees well with the recent determinations of Sève, de Haas and Drapier, and Weiss and Piccard [see Abstracts Nos. 1890 (1912); 518, 874 (1913)]. G. E. A.

1338. *Theory of the Electromagnetic Field in Ferromagnetic Metals.* **W. Arkadief.** (Russian Physico-Chemical Soc., Journ. [Physical Part] 45. pp. 312–344, 1914.)—The theory previously outlined [see Abstract No. 558

(1914)] is here developed in more extended form and illustrated by theoretical curves, which show (1) the course of the magnetic permeability or magnetic conductivity for different values of the damping of the primary magnet ; (2) the variation of the refractive coefficient *n*, or the absorption coefficient *k*, for different values of the damping ; (3) the electromagnetic spectra for certain metals, these representing the behaviour of the metals for different periods of the electromagnetic alternating field. Indications are obtained of two sharply separated regions of electronic and molecular characteristics of matter, corresponding with the divergences from Maxwell's classical theory and showing the limits of validity of this theory. T. H. P.

1339. *Magneto-chemistry of Nickel Compounds and the Magneton Theory.* **B. Cabrera, E. Moles,** and **J. Guzman.** (Archives des Sciences, 37. pp. 324–334, April, 1914.)—The authors have investigated the magnetic susceptibilities of solutions of nickel sulphate, chloride, and nitrate, and of nickel potassium cyanide, all the salts used being chemically and spectroscopically free from cobalt and iron. The results obtained confirm Koenigsberger's conclusion [Abstract No. 824 (1899)] that Wiedemann's law is applicable in all cases. According to Finke's results [Abstract No. 445 (1910)] it seems almost certain that with nickel sulphate, chloride and nitrate, and probably with all salts yielding the kathion Ni, in solutions of all concentrations and perhaps also in the solid salt, the number of magnetons is constant and equal to 16. Assuming the invariability of the number of magnetons in all nickel solutions, the salts studied furnish solutions of widely varying susceptibility, the absolute value of which can be calculated. With the chloride, which is the most soluble, the formula $[33{\cdot}91\,m - 0{\cdot}719\,(1-m)]10^{-6} - 11{\cdot}7\,m(t-20)10^{-6}$, gives the value of χ for a solution containing m gm. of the salt per gm. of solution at t°, which must be in the neighbourhood of 20°, the errors not exceeding about 0·5 per cent. If an accuracy of not more than 1 per cent. is desired, the values of m may be deduced from the quantity of dissolved salt, but more exact results, true to within 0·1 per cent. in the case of concentrated solutions, may be obtained by calculating the value of m from the empirical formula, $m = 1{\cdot}057\,(D_s - D_{aq})_{15^{\circ}} - 0{\cdot}551\,(D_s - D_{aq})^2_{15^{\circ}}$, where D_s and D_{aq} are the densities of the solution and of water. T. H. P.

RADIOLOGY AND ELECTROPHYSIOLOGY.

1340. *New Apparatus for measuring the Intensity of the Röntgen Rays. Furstenau's Intensimeter.* (Archives d'El. Médicale, 22. pp. 489–492, May 10, 1914.) **Immelmann.** (Ibid. pp. 512–518, May 10, 1914. Paper read before the 10. Congrès de la Soc. Allemande de Röntgen.)—The apparatus consists of a selenium receiver and a galvanometer with battery in circuit. The Röntgen rays impinging on the receiver which is placed directly on the skin being radiated, produce a modification in the conductivity of the selenium and, consequently, a displacement of the galvanometer needle. The scale of the galvanometer is graduated in absolute units so that the dose per unit of time can be read directly both for superficial and deep applications. A. E. G.

1341. *Criticism of Dose-meters in Actual Use.* **Grossmann.** (Archives d'Él. Médicale, 22. pp. 511–512, May 10, 1914. Paper read before the 10 Congrès de la Soc. Allemande de Röntgen.)—In the dose-meters a fraction of the Röntgen rays is transformed in some cases into chemical energy, in others into physical energy other than that of the Röntgen rays. If these modifications are to represent an exact measure of the superficial dose of the rays which impinge on the skin, they ought to fulfil the three following conditions: (1) The dose absorbed by the dose-meter, for a homogeneous radiation of no matter what hardness, and, consequently, for a complex radiation of no matter what composition, ought to be proportional to the superficial dose absorbed by the skin. (2) It is necessary always that the same fraction of the dose absorbed by the dose-meter may be transformed into chemical or physical energy and thus measured. (3) The modifications produced in the dose-meter should represent an exact measure of this energy. It has been proved that only substances of atomic weight less than 24 do not emit a characteristic secondary radiation and present for that a regular absorption for all degrees of hardness. In the ionometer air is the substance used, and the elements composing it have atomic weights of 14 to 16. Sabouraud's pastille contains Ba, Pt, C, N, O, and H: the four last may be neglected, Pt has a regular absorption for all degrees of hardness of importance in radiotherapeutics, but with Ba a quick augmentation of the coefficient of absorption takes place for hard rays. Consequently this pastille is not exact for these rays. The photographic paper of Kienböck contains Ag, Cl, and Br. The silver is the most important of these components, for, in its case, a sudden increase of absorption occurs for hard rays. Hence it may be stated that the ionometer is the most exact dose-meter, Sabouraud's pastille takes second place, while Kienböck's paper is the least reliable. A. E. G.

1342. *Comparison of some Radio Dose-meters.* **Lévy-Dorn.** (Archives d'Él. Médicale, 22. pp. 513–514, with Discussion, May 10, 1914. Paper read before the 10. Congrès de Soc. Allemande de Röntgen.)—A table is given showing the relations between the indications of a Sabouraud radiometer and those of the Kienböck quantimeter for degrees of hardness varying from 3–4 to 6–7 degrees Benoist. In the *discussion,* **H. E. Schmidt** made the statement that Kienböck's quantimeter is absolutely useless in practice, and this statement was corroborated by others. A. E. G.

1343. *The Coefficient of Protection of Substances containing Caoutchouc.* **B. Walter.** (Archives d'Él. Médicale, 22. p. 510, May 10, 1914. Paper read before the 10. Congrès de Soc. Allemande de Röntgen.)—Taking the coefficient of protection of lead as 1, then that of caoutchouc with lead is 0·79 to 0·88, while lead glass has a coefficient of 0·30 to 0·54. Certain samples of caoutchouc with lead are found to be conductors for high-tension currents. A. E. G.

1344. *Local Application of Radium in Therapeutics.* **J. Joly.** (Roy. Dublin Soc., Proc. 14. 20. pp. 290–296, May, 1914.)—Discusses the best forms of applicators for various cases with special reference to the amounts of β- and γ-radiation transmitted by screens of different thicknesses. E. M.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1345. *Thermochemistry and the Periodic Law. Heats of Combination Linear Functions of the Atomic Weights of Related Elements.* **W. G. Mixter.** (Amer. Journ. Sci. 37. pp. 519–534, June, 1914.)—The author discusses and represents graphically the relation between heat of formation of the oxides and chlorides of the elements, and shows the periodicity of the same, the heat of formation being a linear function of the atomic weight. Variation from linearity in certain cases is uniform. A. F.

1346. *Alloys of Gold with Arsenic.* **A. P. Schleicher.** (Int. Zeitschr. Metallog. 6. pp. 18–22, March, 1914.)—Alloys of gold and arsenic have been prepared by fusing together the components and pouring the molten mass into water. The alloys thus obtained are very brittle, and show a grey fracture. Thermal analysis of the alloys containing between 100 and 74·58 atomic per cent. of gold gives the eutectic point as 665° and the corresponding As-content as 46–47 atomic per cent. Micrographic investigation gives confirmatory results. T. H. P.

1347. *Silver and Cuprous Oxide.* **C. H. Mathewson** and **C. H. Stokesbury.** (Int. Zeitschr. Metallog. 5. pp. 193–212, Feb., 1914.)—It is shown that cuprous oxide dissolves freely in molten silver, but is practically insoluble in the solid metal. The thermal characteristics and the microstructure of alloys containing up to 20 per cent. Cu_2O are described. Within this range the alloys are similar to those exhibited by the system $Cu—Cu_2O$ (Heyn, Zeitschr. Anorg. Chem. 39. p. 1, 1904). Practically identical structures are obtained in the two eutectic mixtures, Cu 96·5—Cu_2O 3·5 and Ag 98·7—Cu_2O 1·3. The freezing-point of silver is lowered by 16 to 17 deg. by this eutectic proportion of Cu_2O. In all cases the calculated primary freezing-points of the silver are considerably higher than the observed values. This indicates that the dissolved cuprous oxide dissociates or reacts chemically with the solvent so as to increase the number of dissolved molecules. If the equation—

$$Cu_2O + 2Ag \rightleftharpoons 2Cu + Ag_2O$$

represents this reaction, approximately one-quarter of the cuprous oxide added is replaced by copper and silver oxide in these dilute metallic solutions. When a silver-copper alloy containing relatively little copper is melted and solidified with free access of air, the copper occurs as oxide between the polygonal grains of silver. C. O. B.

1348. *Variation of the Resilience of the Industrial Alloys of Copper as a Function of the Temperature.* **L. Guillet** and **V. Bernard.** (Comptes Rendus, 157. pp. 548–550, Oct. 6, 1913.)—The earlier work of the authors [Abstract No. 1531 (1913)] has been extended to brasses richer in zinc, to bronzes containing up to 20 % Sn, and to an alloy containing 1·4 % Zn and 2·4% Al. Plotted in the form of temperature-resilience curves the results confirm the earlier observation on the unfavourable effect of lead. The Al bronzes rapidly lose resilience as the temperature rises the value falling from 25 to 9 kg.-cm.^{2} between 0° and 300° C. In the high-Sn bronzes the resilience is largely a function of the copper-content. Up to 12 % Sn the bronzes show a rapid drop in resilience in the neighbourhood of 200° C. Substitution of part of the tin by lead and zinc causes a lowering of the resilience particularly noticeable at low temperatures. F. C. A. H. L.

1349. *Sound Ingots.* **R. Hadfield.** (Amer. Inst. Mining Engin., Bull. 88. pp. 557–576, April, 1914.)—The author describes and illustrates a number of ingots made by his process [Abstract No. 277 (1913)] in comparison with steel ingots cast by ordinary methods. Ingots cast by the process give a saleable product of at least 88 per cent. and sometimes as high as 95 per cent., while the steel produced is remarkably free from segregation. By a superficial examination it is possible to tell whether the ingot is sound or not. If there is a large cavity in the feeding head the ingot proper is free from honeycombs, blowholes, pipe, and segregation. Special experiments have shown that during solidification about 4 per cent. of the steel in the body of the ingot is drawn from the feeding head. F. C. A. H. L.

1350. *Contribution to the Study of Cementation by Gases.* **F. Kurek.** (Stahl und Eisen, 32. p. 1780, 1914. Rev. de Métallurgie, 11. pp. 160–162, March, 1914. Extract.)—Bars of steel containing 0·09 % and 0·32 % Mn have been heated at various temperatures in CO, methane, and illuminating gas. The progress of carbonisation in CO was observed by determining the quantity of CO_2 in the issuing gases. Carbon monoxide gives a case which never attains the eutectic composition. Methane does not commence to carbonise below 800° C., but above 900° C. carbonisation is rapid and the resulting case high in carbon, *e.g.* at 1000° C. the outer layer took up 1·81 % carbon. Addition of ammonia reduces the carbonising power of both these gases. Illuminating gas begins to carbonise at 800° C. and has a more rapid effect than methane, giving in addition a more highly carbonised case. F. C. A. H. L.

1351. *Hardness of Metals.* **J. H. Andrew.** (Int. Zeitschr. Metallog. 6. pp. 30–48, March, 1914.)—The author summarises the views of Edwards and Grenet on this subject and points out that in several respects the ideas are opposed. Brinell hardness tests on quenched and slowly cooled Cu-Al and Cu-Sn alloys showed that quenching actually softens some of the alloys. This proves that Edwards' theory stating that "any alloy retained as a homogeneous solution which would otherwise consist of two constituents is thereby rendered much harder," does not hold good in all cases. Consideration is then given to the particular case of iron-carbon alloys which differ from the Cu-Al alloys under discussion in that the phases separating at 700° C. are a pure metal (ferrite) and a pure metallic compound (cementite), while in the Cu-Al alloys the phases separating at 570° C. are two homogeneous solid solutions. Further, one of the constituents separating from the iron-carbon alloys at the inversion point, undergoes an allotropic change at the same temperature. In the light of Benedicks' theory austenite consists of a solid solution of carbon or carbide of iron in γ-iron, while martensite is a solid solution of carbon or cementite in a solution of α- and γ-irons. The author believes martensite to be made up of free cementite embedded in a matrix of undecomposed austenite and α-iron, the latter accounting for the magnetic properties of hardened steel, while the hardness is due to the combined effect of the solid solution and the carbide. Alloys of iron and carbon do not appear to fall into line with the non-ferrous alloys in any generalisation on the property of hardness. F. C. A. H. L.

1352. *Volume of Molecules and of the Component Atoms.* **J. D. van der Waals.** (Konink. Akad. Wetensch. Amsterdam, Proc. 16. pp. 880–890, March 26, 1914.)—Taking into account the fact that the factor *b* of van der Waals' equation becomes less than 4 times the volume of the molecules when the volume decreases to almost 2*b*, as it does for the critical state, the following relation holds approximately : $T_k/p_k = 7 \times 273 b_g/(1+a)(1-b)$. If the factor 7 were equally great for all substances, the ratio T_k/p_k would be nearly proportional to the size of the molecules, and as the author's calculations are only of a preliminary character, this is actually assumed to be the case. For the different members of several homologous series of organic compounds, calculations are made from the critical data of the values of T_k/p_k; similar calculations are also made for the constituent atoms of carbon, hydrogen, etc. The results obtained show that for normal compounds, that is, those which do not associate or dissociate under the critical conditions, the volume of the molecule is equal to the sum of the volumes of the component atoms. The volume of an atom is not, however, constant, but depends on the atoms to which, and the manner in which, it is bound. Thus, when united with others, atoms behave, as it were, as soft bodies, which can vary in both size and shape An explanation of this is given by the conception that an atom is an orbit of electrons round a rigid centre formed by a point in which the atomic weight is concentrated or, when the atom is bi-, tri-, or tetravalent, by 2, 3, or 4 orbits round centres in which one-half, one-third, or one-fourth of the atomic weight is concentrated. In this way the modification of the size in case of mutual binding may possibly be determined.

With benzene and other cyclic compounds the values of the above ratio are decidedly smaller than those calculated additively from the constituent atoms and comparison of the values for benzene and naphthalene leads to the conclusion that the smallness is to be ascribed not to the hydrogen atoms but to the carbon atoms. T. H. P.

1353. *Ozone Formation at Different Pressures.* **H. v. Wartenberg** and **L. Mair.** (Zeitschr. Elektrochem. 19. pp. 879–881, Nov. 15, 1913.)—The experiments were made with a tubular apparatus, an outer tube of gilt brass and an inner tube of silvered glass, the oxygen entering and leaving through capillary tubes. The distance between the two electrodes was 2 or 6 mm., and the flow of gas was so regulated that the oxygen particles were exposed to the action of the field (1 milliamp. or less, up to 23,000 volts, 50 $\sim$) for equal times, mostly 5 minutes. The pressure varied between 0·5 and 5 atmos., and it was found that both the ozone concentration and the ozone yield (in mgm. of O_3 per watt-second) had a decided maximum between 0·5 and 1 atmo. H. B.

1354. *Solubility of Gases in Liquids.* **M. Kofler.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 1461–1472, July, 1913.)—The view has been advanced that the solubility of gases depends on the magnitude of the intermolecular spaces in a liquid. There is a marked parallelism between solubility and compressibility on comparing (1) a given solvent at different temperatures, (2) different solvents at the same temperature, (3) aqueous salt solutions, (4) aqueous sulphuric acid. The solubility-temperature curves for hydrogen and helium in water pass through a minimum, which also appears in the compressibility-temperature curve for this solvent. There appears also to be a relationship between solvent power for gases and dielectric constant, since the true volume occupied in a liquid may be expressed by the formula $V = (K - 1)(K + 2)$. Finally the solubility appears to be influenced by the critical temperature of the dissolved gas; thus, all gases having a low critical temperature are sparingly soluble in water; again a fairly regular curve can be obtained by plotting log α (α = solubility at 0° C.) against the "corresponding temperature," T/T_k, of the freezing-point of water relatively to the critical temperature of the gas. T. M. L.

1355. *Conductance and Viscosity of Electrolytic Solutions.* **C. A. Kraus.** (Amer. Chem. Soc., Journ. 36. pp. 35–65, Jan., 1914.)—In the case of aqueous solutions exhibiting negative viscosity, the conductance may be corrected for viscosity by a proportional factor; this is probably true also for alteration of viscosity by external pressure. But when the viscosity is greater than that of water, the conductivity diminishes less quickly than the fluidity; a correction may perhaps be made by considering the effect of viscosity on the individual ions. The influence of viscosity on the transference numbers is due to the unequal effects of viscosity on the two ions, depending largely on the relative sizes of the ions and of the molecules of the solute. The influence of rise of temperature is to equalise the speeds of the different ions, indicating that the ions approximate to equal sizes; but the unusual view is adopted that this effect depends on increasing size of the smaller ions due to increasing hydration, instead of to loss of water by the larger ions. No support could be found for the view that the exceptional velocity of hydrogen and hydroxyl is related to the fact that they are the ions of the solvent water. In non-aqueous solutions the speed of the ions changes far less than the fluidity, and in many cases no correction is needed up to normal concentration. T. M. L.

1356. *Intermiscibility of Liquids.* **J. Holmes.** (Chem. Soc., Journ. 103. pp. 2147–2166, Dec., 1913.)—The author has a method of determining molecular complexity from the changes of volume which occur on mixing two liquids. He concludes (in opposition to evidence derived from almost all other sources) that carbon disulphide is four times more complex than ethyl ether, and that esters such as ethyl tartrate are four times less complex. The paper contains, however, a large number of accurate measurements of the densities of liquid mixtures, and discloses in the case of mixtures of chloroform and amylalcohol a contraction on mixing which increases to a maximum, then diminishes and changes to an expansion, which in turn increases to a maximum and then decreases again. In the case of chloroform and acetone also there is a change from an expansion to a contraction, although the second maximum was not quite reached within the range of the measurements made. T. M. L.

1357. *Determination of Viscosity.* **M. P. Applebey.** (Chem. Soc., Journ. 103. pp. 2167–2171, Dec., 1913.)—In reply to criticisms by Bingham [Abstract No. 1751 (1913)] the author defends the method of expressing viscosities relatively to water, rather than in absolute units. Thus in his experiments the variations in the relative viscosities were only 0·009 %, where the absolute values of Bingham and White varied by 0·07 % and differed from those of Thorpe and Rodger by 0·6 %. Reduction to absolute units therefore introduces errors far larger than those occurring in relative measurements of the viscosity of solutions.

In making relative measurements it is possible to use a capillary tube which tapers at the ends. This is a real advantage in securing uniform flow and preventing eddies, but has to be sacrificed when absolute measurements are made. Some additional hints are given for securing constancy of experimental conditions. T. M. L.

1358. *The Water-gas Equilibrium in Hydrocarbon Flames.* **G. W. Andrew.** (Chem. Soc., Journ. 105. pp. 444–456, Feb., 1914.)—The author has studied the water-gas equilibrium by firing various mixtures of methane, ethane, ethylene, and acetylene with oxygen, and determining the composition of the gas mixture produced. In all cases the value of $K = C_{CO} \times C_{H_2O}/C_{CO_2} \times C_{H_2}$ was nearly constant, and nearly independent of the max. flame temperature. It is therefore argued that the experimentally determined constant probably does not correspond with the max. flame temperature but is characteristic of some hypothetical temperature, the equilibrium condition at which corresponds with the integration of the chemical changes which occur in a rapidly cooling mixture from higher to atmospheric temperatures. The hypothetical temperature corresponds to between 1500–1600°. It thus appears that the reaction $CO + H_2O \rightleftarrows CO_2 + H_2$ proceeds with great rapidity during cooling. Although practically the same value was obtained for K in the above experiments, the author considers that secondary reactions play an important rôle. A. F.

1359. *Limits of Visibility of Precipitates.* **L. Rolla.** (N. Cimento, 6. Ser. 6. pp. 249–254, Oct., 1913.)—The solubilities of AgCl, AgBr, and AgI, determined electrochemically, are found to be $1{\cdot}2 \times 10^{-5}$, $5{\cdot}0 \times 10^{-7}$, and $1{\cdot}0 \times 10^{-8}$ respectively. By means of the ultramicroscope estimations were made of the concentrations of silver nitrate which just gave visible precipitates with the chlorides, bromides, and iodides of sodium and potassium. With the three types of salts, the visibility begins at $0{\cdot}9$–$1{\cdot}5 \times 10^{-5}$, 4–5×10^{-7}, and $0{\cdot}8$–$1{\cdot}0 \times 10^{-8}$ respectively, these values all agreeing with those given by the electrochemical method. The ultramicroscope gives for the solubility of HgCl, $4{\cdot}5 \times 10^{-6}$, which differs from the value obtained electrochemically, and for that of HgBr, 8×10^{-7}. The accuracy of the above figure for HgCl is shown by the fact that the affinity of the reaction is 1·465 volts, when calculated from the e.m.f., and 1·454 or 1·42 volts—according to the values of the chemical constants employed—when calculated from the solubility. T. H. P.

1360. *Connection between Electrolytic and Chemical Processes.* **D. Reichinstein.** (Zeitschr. Elektrochem. 19. pp. 672–676, Sept. 1, and pp. 914–920, Dec. 1, 1913.)—The hitherto overlooked researches of J. J. Andrejew of 1907 on retardation in the solution of gold in aqueous cyanide show that, when the cyanide solution contains oxidising agents, the rate of solution increases to a maximum with increasing concentration of these agents and decreases afterwards. The author finds analogies in the electrolytic solution of active and passive (polarised) metals, in which an oxygen-metal alloy is first formed. When the oxygen concentration of this alloy is increased by increasing the proportion of the oxidising agent or the current, a critical oxygen concentration is reached. The formation of such an alloy (hypothetical solution) at the boundary between two phases is alone able to account for the chemical and the electrolytic phenomena with reversible electrodes. The experiments were made with the aid of the oscillograph.

The second paper discusses the equilibrium conditions in those alloys. On the old hypothesis there was always to be equilibrium between electrode and alloy even while the current was flowing. But the passage of the current must disturb the equilibrium, and what remains constant is the sum of the concentrations of all the substances which constitute the hypothetical alloy. There is a compensation process, subject to chemical inertia, between the constituents, and on this process depends the polarisation. Reference is particularly made to the author's experiments of 1910 and 1913 on Pd electrodes in sulphuric acid which zinc salt is added; this addition results in a negative depolarisation, and zinc is deposited. H. B.

1361. *Electrolysis in Non-aqueous Solvents: Potassium o-Nitrobenzoate in o-Nitrobenzoic Acid.* **J. C. Schall.** (Zeitschr. Elektrochem. 19. pp. 880–883, Nov. 1, 1913.)—The author and R. Klien had, in 1898, when electrolysing sodium *o*-nitrobenzoate fused in its own acid, obtained nitrobenzol instead of di-*o*-dinitrophenyl expected on analogy with the behaviour of fatty acids dissolved in water. E. Berl had suggested that the electrolysis yielded, in the absence of water, sodium which caused the reduction to nitrobenzol. The author now electrolyses the potassium salt, fused at 160 to 170° in its acid, in a beaker, in which a small porous pot is placed (hot) containing the anode, a Pt-wire; its kathode, also of Pt, surrounds the pot. Electrolysis by currents of 0·5 amp. at 0·5 volt, the temperature mentioned being maintained, yielded mainly a blackish product, which could not be analysed; a smell of aniline, not of nitrobenzol, and of isonitrile was noticed. The attempted electrolysis of copper-*o*-nitrobenzoate according to M. Lilienfeld (D.R.P. 147,948) failed likewise. H. B.

1362. *Electro-deposition of Nickel.* **C. W. Bennett, H. C. Kenny,** and **R. P. Dugliss.** (Journ. Phys. Chem. 18. pp. 373–384, May, 1914.)—Calhane and Gammage [Abstract No. 2127 (1907)] in their investigations of the electro-deposition of nickel from a solution of nickel ammonium sulphate, using commercial Ni anodes, found that the current efficiency was greater with stationary than with rotating kathodes, whilst the amount of iron deposited as impurity increased when the kathode was rotated. The authors have confirmed these results, and, in the light of further experiments, give a satisfactory explanation of them, which is as follows: From the solution of nickel ammonium sulphate, which is neutral or slightly acid, hydrogen will first be deposited at the kathode. The solution in the neighbourhood of the kathode consequently becomes alkaline, and then, and only then, can Ni be deposited. Thus the efficiency of deposition of the Ni depends on the maintenance of a kathode film which is alkaline; stirring the electrolyte removes this alkaline film, more or less completely, depending on the efficiency of the stirring, and thus the current efficiency diminishes.

It was further shown that the efficiency can be started high and maintained high by adding a definite amount of ammonium hydroxide to the solution. The fact that the iron content of a deposit formed on a rotating kathode is greater than that formed on a stationary electrode is probably due to mechanical occlusion of the precipitated iron hydroxide from the alkaline solution. The iron content of the anode does not materially affect the efficiency. T. S. P.